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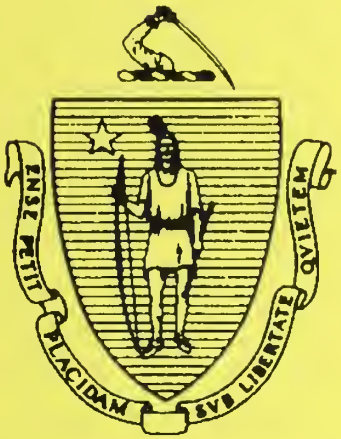

Bureau of Environmental
Health Assessment,
Community Assessment
Unit

Health Consultation:

Assessment of Cancer Incidence in Natick, Massachusetts 1982-1992

Under Cooperative
Agreement with the
Agency for Toxic
Substances and Disease
Registry

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Health Consultation
Assessment of Cancer Incidence in Natick, MA 1982-1992

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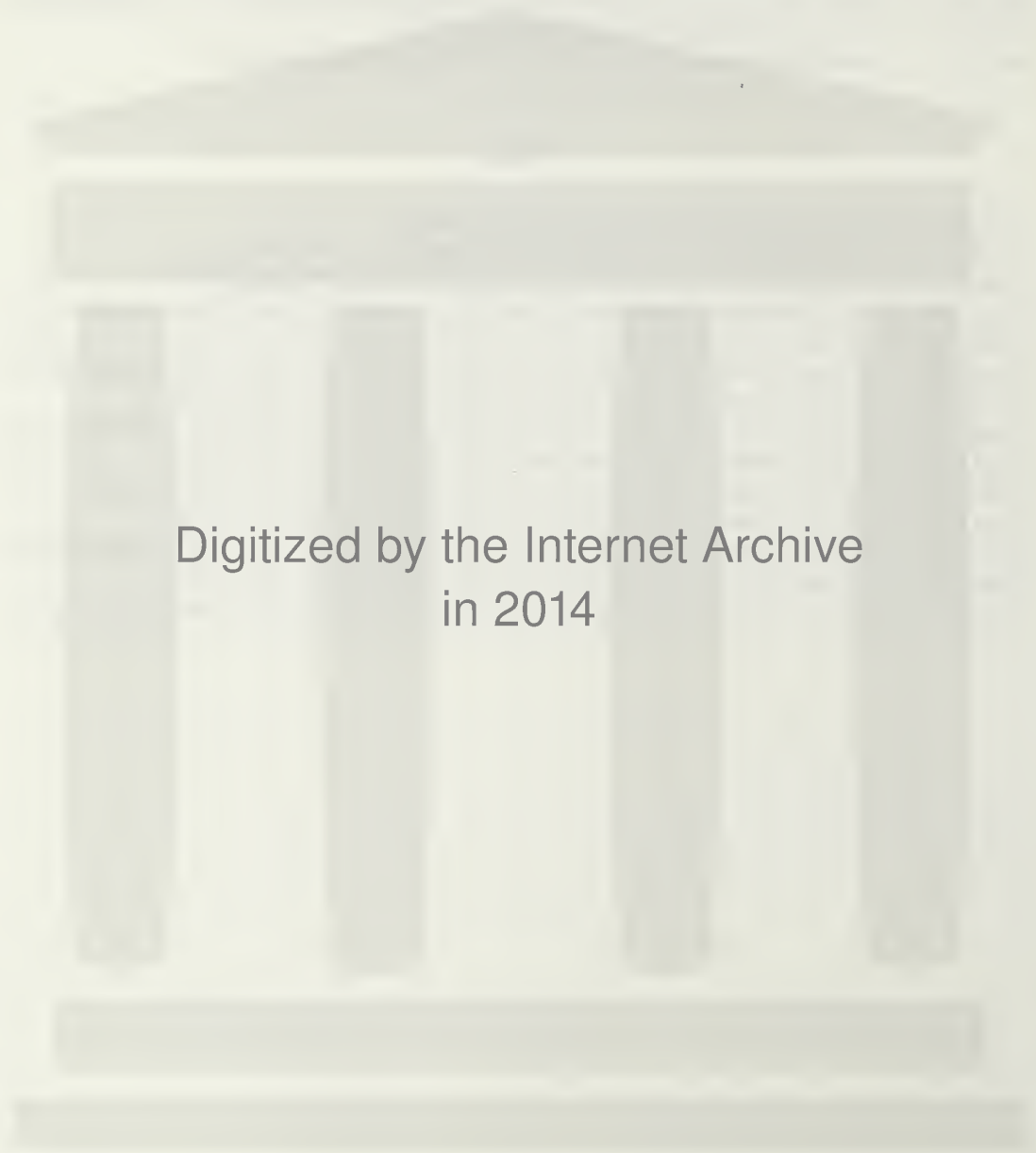

I. INTRODUCTION

At the request of citizens of the town of Natick, the Community Assessment Unit (CAU) of the Massachusetts Department of Public Health, Bureau of Environmental Health Assessment (MDPH, BEHA) conducted an evaluation of cancer incidence in Natick, Massachusetts. Specifically, the requests initiating this investigation included the following concerns:

- Citizen concerns about increased cancer in the community around the U.S. Army Soldier System Command-Natick (SSC-N), particularly the Ash Street area. The SSC-N or Natick Laboratories site is located on Kansas Street in the central portion of the town. The site was placed on the U.S. Environmental Protection Agency (USEPA) National Priorities List (NPL) in 1994 due to contamination detected at the property in several environmental media, including groundwater, soil, and sediments (USEPA 1993).

- Citizen concerns in the northeast portion of Natick regarding the possibility of a relationship between cancer incidence and contamination detected at the Maffei property located on Wellesley Road Extension.

- Additionally, concerns have been raised regarding increased cancer incidence in several other areas of the town including: Chester Street, Lanes End Road, Evergreen Road and the Liberty Street/Russell Circle area in the Wethersfield section of Natick.

II. OBJECTIVES

This health consultation is a preliminary investigation that analyzes descriptive health outcome data such as cancer incidence data to determine whether an elevated rate of cancer exists in the town of Natick or in any of the six census tracts that compose the town. Information from such descriptive analyses, which may suggest that a common etiology is possible, can serve to identify areas where further public health investigations or actions may be warranted.

The objectives specific to this investigation were to:

- determine whether elevated rates of cancer exist in the town of Natick or any of its six census tracts (3821-3826) as compared to cancer incidence in the state of Massachusetts;

- evaluate temporal trends of cancer incidence in the town of Natick and its census tracts during the period 1982-1992 and two smaller time periods 1982-1986 and 1987-1992;

- evaluate the geographic distribution of cancer cases in Natick;
- review available environmental data to determine whether an association with the incidence of cancer in Natick is possible; and
- discuss the results in the context of the available scientific literature on cancer to determine whether further investigation and/or public health action is warranted.

III. CANCER INCIDENCE ANALYSIS

A. Methods for Analyzing Cancer Incidence Data

The term cancer is used to describe a variety of diseases associated with abnormal cell and tissue growth. These different diseases are classified by primary site (location in the body where the disease originated) and histology or cell type. Epidemiologic studies have revealed that different histologic types (or primary site) of cancer are individual diseases with separate causes, risks, characteristics and patterns of survival (Schottenfeld and Fraumeni 1996).

Eleven types of cancer were evaluated in this investigation. These include cancers of the bladder, brain, breast, kidney, liver, lung (including bronchus), pancreas and stomach, as well as Hodgkin's disease, non-Hodgkin's lymphoma (NHL) and leukemia. These cancer types were selected in order to address concerns raised by citizens of Natick regarding suspected elevations in the incidence of these cancer types or because the scientific literature has suggested an environmental association with some of these cancer types may be possible.

In order to evaluate cancer incidence, standardized incidence ratios (SIRs) were calculated for the period 1982-1992 for each type of cancer for the town of Natick and each of its six census tracts 3821-3826. SIRs were also calculated for the two time periods 1982-1986 and 1987-1992, in order to evaluate temporal trends in cancer incidence. SIRs were not calculated when fewer than five cases were observed. Available risk factor information, as reported to the Massachusetts Cancer Registry (MCR) (e.g., smoking status and occupation) was also reviewed for specific cancer types.

Cancer incidence data for the years 1982-1992 were obtained from the MCR. The MCR has been monitoring cancer incidence in the state of Massachusetts since 1982. The 11-year period 1982-1992 was the most complete data available from the MCR at the time of this evaluation. To determine whether elevated numbers of cancer cases have occurred in the town of Natick, cancer incidence data were analyzed by age and sex to compare the observed number of cancer cases in the town or in each census

tract (CT) to the number that would be expected based on the statewide cancer experience.

In order to calculate incidence rates, it is necessary to obtain accurate population information. The population figures used in this analysis were interpolated based on 1980 and 1990 census data for each town (U.S. DOC 1980, 1990). To estimate the population between census years, an assumption was made that the change in population occurred at a constant rate throughout the ten year interval between each census. From these calculations, 1987 population estimates were obtained for the town and for each census tract in the town of Natick. Population estimates for the year 1987 were used to calculate SIRs for each time period evaluated.

An SIR estimates the occurrence of disease in a population relative to what might be expected if the population had the same cancer experience as some larger population designated as "normal" or average. Usually, the state as a whole is selected to be the "normal" population.

Specifically, an SIR is the ratio of the observed number of cancer cases to the expected number of cases. An SIR of 100 indicates that the number of cancer cases observed in the population being evaluated is equal to the number of cancer cases expected in the normal population. An SIR greater than 100 indicates that more cancer cases occurred than expected; an SIR less than 100 indicates that fewer cancer cases occurred than expected. Accordingly, an SIR of 150 is interpreted as 50% more cases than the expected number; an SIR of 90 indicates 10% fewer cases than expected.

Caution should be exercised, however, when interpreting an SIR. The interpretation of an SIR depends on both the size and the stability of the SIR. Two SIRs can have the same size but not the same stability. For example, an SIR of 150 based on two expected cases and three observed cases indicates a 50% excess in cancer, but the excess is actually only one case. Conversely, an SIR of 150 based on two hundred expected cases and three hundred observed cases represents the same 50% excess in cancer, but because the SIR is based upon a greater number of cases, the estimate is more stable. It is very unlikely that 100 excess cases of cancer would occur by chance alone.

To determine if the observed number of cases is significantly different from the expected number or if the difference may be due solely to chance, a 95% confidence interval (CI) is calculated (Rothman and Boice 1982). A 95% CI is the range of estimated SIR values that has a 95% probability of including the true SIR for the population. If the confidence interval range does not include the value 100, then the study population is significantly different from the "normal" population. "Significantly different" means there is less than five percent chance that the observed difference is merely the result of random fluctuation in the number of observed cancer cases. For example, if a confidence interval does not include 100 and the interval is above 100, then there is a significant excess in the number of cancer cases. Similarly, if the confidence

interval does not include 100 and the interval is below 100, then the number of cancer cases is significantly lower than expected. If the confidence interval range includes 100, then the true SIR may be 100, and it cannot be concluded with sufficient confidence that the observed number of cases reflects a real cancer excess or deficit. Statistical significance is not assessed when fewer than five cases are observed.

In addition to the number of cases, the width of the confidence interval also reflects the stability of the SIR estimate. For example, a narrow confidence interval (e.g., 103--115) allows a fair level of certainty that the calculated SIR is close to the true SIR for the population. A wide interval (e.g., 85--450) leaves considerable doubt about the true SIR, which could be much lower than or much higher than the calculated SIR. This would indicate an unstable statistic.

The geographic distribution of cancer cases was determined using available information from the MCR regarding the place of residence at diagnosis. This information was mapped for each individual using the computer software MapInfo (MapInfo 1994). In instances where the address information was incomplete (i.e., did not include specific streets or street numbers), efforts were made to research those cases using telephone books and residential lists issued within two years of an individual's diagnosis.

The available smoking status and occupational information as reported to the MCR were analyzed when pertinent to the cancer type. Smoking status information was reviewed for cancers with known or suggested associations with tobacco smoke (Schottenfeld and Fraumeni 1996). For Natick, this includes cancers of the bladder, lung, kidney, and pancreas.

The observed number of cancer cases reported in the following sections for Natick are in some instances slightly different from the observed number of cases shown in the MCR report, *Cancer Incidence in Massachusetts 1982-1992 City and Town Supplement* (MDPH 1995a). The data contained in the *City and Town Supplement* reflect information entered in the MCR computer files prior to the date this file was closed and made available for research. The data in this research file are constantly being quality controlled so that corrections may be made in subsequent reports. Occasionally, the research file may contain duplicate cases.

The data discussed in this report have been controlled for duplicate cases. The analyses account for duplicate cases by removing the duplicate cases while including multiple primary cancer cases. A multiple primary cancer case is defined by the MCR as a new cancer of the same histology as an earlier cancer, if diagnosed in the same primary site (or original location in the body) more than two months after the initial diagnosis (MCR 1996). Duplicate cases are additional reports of the same primary site cancer case. The decision that a case was a duplicate and should be excluded from the analyses was made by the MCR after consulting with the reporting facilities and obtaining additional information regarding the histology and/or pathology of the case.

In addition, the MCR compiles and reports tumors originating in the central nervous system as one group. This group of tumors includes malignant brain tumors, spinal cord tumors, nerve sheath tumors and benign tumors of the brain and spinal cord. Because of differences in risk factors associated with primary brain cancer and cancers originating from other sites in the central nervous system (the majority of which develop due to congenital disorders), for purposes of this report, only primary brain tumors have been analyzed. Primary brain tumors are those tumors that arise from the brain and its coverings. Metastatic brain tumors, which result from other types of primary cancer spreading to the brain, were not included in this analysis (Black 1991a).

B. Cancer Incidence in Natick

Tables 1 through 7 summarize the cancer incidence data townwide and for each census tract for three different time periods: 1982-1986, 1987-1992, and for the entire 1982-1992 period. Figure 1 depicts the location and boundaries of the six census tracts in Natick. The following sections present results for Natick as a whole and then for each census tract. The census-tract-specific analyses help in understanding whether the incidence of cancers observed townwide may be explained by an increase or decrease in cases in a particular geographic area of the town.

Cancer Incidence in Natick as a Whole (Tables 1A & 1B)

During the 11-year period 1982-1992, cancer incidence in the town of Natick as a whole occurred at about or below expected rates overall and among males. In general, females in Natick experienced higher rates of cancer than expected, although no cancer was statistically significantly elevated among females. Among males and females combined, elevations occurred in cancers of the breast (258 cases observed vs. approximately 241 cases expected) and pancreas (41 cases observed vs. approximately 31 cases expected). In addition, the incidence of pancreatic cancer was elevated among both males and females when evaluated separately. The elevation in pancreatic cancer was mainly based on an increase of seven cases which occurred among males. Females experienced an excess of approximately three cases during the time period evaluated. The elevations observed in these two cancer types were not statistically significant.

Stomach cancer occurred significantly less often among males during the 11-year period evaluated. In addition, the incidence of this cancer occurred less often than expected in both time periods 1982-1986 and 1987-1992. Hodgkin's disease occurred greater than expected among males although not significantly.

An elevation in the incidence of brain cancer was observed among males during the earlier time period 1982-1986 (9 cases observed vs. approximately 5 cases expected). The incidence of pancreatic cancer was also elevated among males during this time period (11 cases observed vs. 6.8 cases expected). Cancers of the liver, lung, stomach as well as leukemia occurred less often than expected. Cancer incidence among females

occurred generally at expected rates. An increase of six cases of breast cancer occurred during the earlier time period, but the elevation was not significant.

With the exception of stomach cancer and Hodgkin's disease, cancer incidence among females during the later time period 1987-1992 was greater than expected for each of the cancer types evaluated. Although elevations were consistently noted among females during this time period, none of the observed increases were statistically significant. Most of the elevations observed were based on a small number of cases (i.e., three or less). However, the increase in breast cancer was due to approximately 13 cases. Overall, males experienced less cancer incidence than expected during 1987-1992. Increases in bladder and pancreatic cancers and Hodgkin's disease were noted among males. None of the increases were statistically significant.

C. Cancer Incidence in Natick Census Tracts

Census Tract 3821 (Tables 2A & 2B)

During the period 1982-1992, cancer incidence occurred at about or below the expected rate among males, females and males and females combined in CT 3821 for most of the cancer types evaluated. No cases of liver cancer occurred in CT 3821 during the eleven year period 1982-1992.

Bladder cancer occurred equal to or less often than expected for all three time periods examined and for both sexes. Brain cancer occurred less often than expected during the period 1982-1992 overall and for both sexes. One case of brain cancer was observed (versus 0.8 cases expected) among males during the earlier period 1982-1986. No cases of brain cancer occurred in the later time period.

Breast cancer was elevated during 1982-1992 and during the earlier time period 1982-1986. The observed elevations however were not statistically significant. Overall, five excess cases of breast cancer were observed among females in this census tract. The incidence of breast cancer was approximately equal to the expected rate during the period 1987-1992. One case of breast cancer occurred among males during the period 1982-1986.

Kidney cancer occurred at a rate approximately equal to what would have been expected in total incidence and among males during the 11 years 1982-1992 as well as the two smaller time periods. Among females, the incidence of this cancer was slightly elevated for each of the three time periods evaluated. The increases observed among females were generally based on one or two cases and were not statistically significant.

Lung cancer occurred less often than expected among both sexes and during each of the three time periods evaluated. During the earlier time period 1982-1986, the incidence of lung cancer occurred at a rate approximately 50 percent less than expected. This decrease in lung cancer was consistent for both sexes.

Pancreatic cancer occurred more than twice as often as expected during the period 1982-1992 among males and females combined (SIR=210). Ten cases occurred and approximately five cases were expected. The observed increase in this cancer was statistically significant. When evaluated over time, the incidence of pancreatic cancer was also statistically significant in the earlier time period but occurred less often than expected during the later time 1987-1992. The elevation observed during 1982-1986 was more than three times greater than expected among males and females combined (SIR=361). Pancreatic cancer was also increased during this time period in males and females when evaluated separately. The increases were based on approximately three excess cases each.

Evaluation of available information regarding smoking status for these individuals revealed that three individuals reported a smoking status as current or former smoker, four individuals reported having never smoked and smoking status was unknown for three individuals. Available occupational information did not indicate that any of these individuals worked in an occupation associated with an increased risk of pancreatic cancer at the time of diagnosis (Schottenfeld and Fraumeni 1996). However, occupational information was incomplete (i.e., retired or unknown) for three of the ten individuals. It is also important to note that the available occupational information was generally limited to job title or type of industry.

Stomach cancer occurred less than or equal to expected rates during the three time periods evaluated. Overall, during the 11 years 1982-1992, two cases occurred and approximately five cases were expected in this census tract. Hodgkin's disease also occurred less often than expected. One case occurred during the later time period 1987-1992.

With the exception of males, the incidence of NHL occurred equal to or less often than expected. An elevation in NHL was observed overall and among males during the later time period 1987-1992. The observed elevation was based on an excess of less than three cases and was not statistically significant.

The incidence of leukemia was slightly elevated among females and in total incidence during the period 1982-1992. The elevation was observed only during the later time period. Four cases occurred among females where slightly less than one case was expected. No cases were observed among males during 1987-1992.

Census Tract 3822 (Tables 3A & 3B)

Bladder cancer occurred more often than was expected during the 11-year period 1982-1992. The incidence of bladder cancer was also elevated during the earlier time period 1982-1986. The observed elevations were based on increases of approximately two to three cases and were not statistically significant.

The incidence of brain cancer in CT 3822 occurred generally less often than expected. During the earlier time period 1982-1986, two cases were observed among males and approximately one case was expected. Among males in the later time period, brain cancer occurred slightly less often than expected. No cases occurred among females during the period 1982-1992.

Cancers of the breast and kidney also occurred about as or less often than expected during the 11-year period 1982-1992 as well as the two smaller time periods evaluated. No cases of liver cancer were observed in CT 3822 during the 11-year period 1982-1992

Lung cancer occurred slightly more often than expected during the period 1982-1992 among males, females, and males and females combined. The observed elevations were consistent in each of the smaller time periods examined and occurred among both sexes. None of the elevations observed were statistically significant.

Although small elevations in lung cancer were observed in CT 3822, review of available information on smoking and occupation showed it is possible that these factors may have played a role in the development of lung cancer among some of the individuals in this area of the town. Among the lung cancer cases for which smoking status was reported, 91% (n=31) were a current or former smoker at the time of diagnosis of their cancer. Nine percent (n=3) of the individuals with lung cancer who reside in CT 3822 reported a smoking status as never smoked. Smoking status was unknown for eight cases. Information regarding occupation as reported to the MCR was unknown for nearly half (48%, n=20) of the cases in this census tract. One individual reported an occupation where exposure to carcinogens associated with the development of lung cancer may be possible (Schottenfeld and Fraumeni 1996).

Pancreatic cancer was slightly elevated overall and among males during the 11-year period 1982-1992. The elevation overall was mainly due to an increase in pancreatic cancer among males during the earlier time period 1982-1986 (3 cases observed vs. 1.1 expected). Among females, pancreatic cancer occurred less often than expected in all three time periods evaluated.

The incidence of stomach cancer and Hodgkin's disease was generally less than or about as expected during the three time periods evaluated. There were no cases of Hodgkin's disease among females during 1982-1992 in CT 3822.

The incidence of NHL occurred less often than expected overall and among males during the entire time period 1982-1992. Among females the incidence of NHL was increased during each of the three time periods evaluated. Overall, six cases occurred among females where approximately four cases were expected. Males experienced less NHL than expected in each of the time periods 1982-1986 and 1987-1992.

Leukemia occurred at or below the expected rate during each of the three time periods evaluated and among both sexes. During the entire eleven year period 1982-1992, four cases were observed where 4.3 cases were expected.

Census Tract 3823 (Tables 4A & 4B)

The incidence of bladder cancer was greater than expected overall and among males during the period 1982-1992. Females experienced bladder cancer at approximately the expected rate during this time. When evaluated by smaller time period, bladder cancer occurred equal to or less often than expected during the earlier time period, 1982-1986. However, during the later time period 1987-1992, increases were observed in this cancer overall and among males. Both of these elevations were statistically significant. Among males, nine cases were observed where approximately four cases were expected (95% CI=105-437).

Available information regarding smoking status at the time of diagnosis indicated that for those individuals for which smoking status was known, approximately 64% (n=7) were current or former smokers and 36% (n=4) reported never having smoked. Smoking status at the time of diagnosis was unknown for three individuals. Among males in CT 3823 during 1987-1992 in which a statistically significant elevation was observed, the majority of individuals were current or former smokers (n=7). Only one male during this time period reported smoking status as never smoked, and information was not available for one male.

Review of occupational information as reported to the MCR indicated that none of the individuals diagnosed with bladder cancer in CT 3823 worked in an occupation that has been associated with an increased risk of developing this type of cancer (Schottenfeld and Fraumeni 1996). However, occupation was unknown for approximately 54% (n=7) of the cases. Among males diagnosed during the second time period, occupation was unknown for seven of the nine individuals. It is important to note that occupational information available was generally limited to job title or type of industry.

Cancers of the brain, kidney, liver, stomach, Hodgkin's disease and NHL occurred generally equal to or less often than expected during the three time periods evaluated.

Female breast cancer was elevated overall in 1982-1992 and during the earlier time period 1982-1986. Neither of the elevations observed were statistically significant. Female breast cancer occurred slightly less often than expected during the later time period 1987-1992. No cases of breast cancer occurred in males.

Lung cancer occurred less than expected overall and among males in each of the three time periods evaluated. Among females, lung cancer was elevated during the later time period 1987-1992 and during the 11 years 1982-1992. Neither of these elevations

were statistically significant. Available smoking status information for females in this census tract revealed that all of those individuals with a known smoking status were current or former smokers.

Pancreatic cancer was elevated, although not significantly, overall and in both sexes during the entire time period 1982-1992. Among males and females combined 10 cases occurred and 5 cases were expected (SIR=198). When evaluated by smaller time periods the elevation could be primarily attributed to small increases (i.e., 3 observed/1 expected) in males during both time periods 1982-1986 and 1987-1992.

Leukemia was statistically significantly elevated among females during the period 1982-1992 (no cases occurred among males. Overall, six cases occurred in this census tract where two cases were expected (SIR=302). The observed elevation was mainly due to a statistically significant elevation in females during the earlier time period 1982-1986. Five cases occurred where less than one case was expected (SIR=530; 95% CI=171-1237). During the later time period, however, females experienced leukemia at the expected rate.

Census Tract 3824 (Tables 5A & 5B)

Overall in CT 3824, cancer incidence occurred slightly more often than expected during the period 1982-1992. Cancers of the kidney and stomach as well as leukemia occurred about as or less often than expected. Lung cancer generally occurred less often or equal to expected overall and among males in each of the three time periods. A slight increase was observed in females in the earlier time period. However, the excess was due to less than three cases and was not statistically significant. Liver cancer and Hodgkin's disease in this census tract occurred at approximately the expected rate during the eleven year period evaluated. Two cases of liver cancer and three cases of Hodgkin's disease were observed.

Bladder cancer occurred approximately as expected overall during the 1982-1992 period. No cases occurred in males during 1982-1986, but more cases occurred in males than expected during 1987-1992. However, the increase was due to about three excess cases and was not statistically significant.

Brain cancer was elevated overall and among males in total incidence as well as during each of the two smaller time periods. The observed increases were based on about one to two cases and were not statistically significant.

Female breast cancer occurred at approximately the expected rate during the period 1982-1992 (SIR=104). Forty-one cases were observed where approximately 40 were expected. During the earlier time period, female breast cancer occurred less frequently than expected. A non-statistically significant increase was observed during the later time period 1987-1992 (30 cases observed vs. 23.2 cases expected). No cases occurred in males.

Pancreatic cancer was slightly elevated among males, females and in total incidence during the later time period 1987-1992. However, during the earlier time period, pancreatic cancer occurred less often than expected. Although elevations were observed in each of the sexes in the later time period, neither of the observed increases was statistically significant and the excesses were due to approximately one case.

The incidence of NHL was greater than expected in each of the sexes and in all three time periods evaluated. Overall, during the period 1982-1992, 12 cases were observed and approximately eight cases were expected. Although, the incidence of this cancer was increased consistently throughout time and among both sexes, the increases were based on a small number of excess cases and were not statistically significant.

Census Tract 3825 (Tables 6A & 6B)

Bladder cancer was elevated overall and among males during the entire 11-year time period as well as during the later time period 1987-1992. The elevations observed were not statistically significant. Females experienced bladder cancer about as often as expected during the earlier time period. There were no cases of female bladder cancer observed during the period 1987-1992.

Cancers of the brain, breast, kidney, liver, and leukemia occurred about as often as expected during all three time periods.

Lung cancer occurred consistently less often than expected among males, females and males and females combined in each of the three time periods evaluated.

Cancers of the pancreas, stomach, and NHL occurred approximately equal to or less than expected during each of the three time periods evaluated. For those cancers that were elevated, the elevations were based on less than one excess case.

Hodgkin's disease was slightly elevated among males during the 11-year period 1982-1992 and during each of the smaller time periods. The elevations observed were not statistically significant. There were no cases of Hodgkin's disease among females in CT 3825.

Census Tract 3826 (Tables 7A & 7B)

Bladder cancer occurred less often or at the rate expected during all three time periods.

The incidence of brain cancer was increased during the 11-year period 1982-1992. The increase was mainly due to a small elevation among females during the later time period 1987-1992. Males experienced brain cancer at approximately the expected rate in all three time periods evaluated. Although slight elevations were observed among

females in this census tract, the elevations were based on a small number of excess cases and were not statistically significant.

Female breast cancer occurred less often than expected during the earlier time period 1982-1986. However, breast cancer occurred more often than expected overall and during the second time period 1987-1992. During the later time period, 41 cases occurred where approximately 30 cases were expected (SIR=135). The elevation observed during this time period was nearly statistically significant (95% CI = 97-183).

During the period 1982-1992, the incidence of kidney cancer was elevated among males and females. A statistically significant elevation in this cancer occurred among males and females combined. Overall, thirteen cases occurred in this census tract where approximately seven cases were expected (SIR=193; 95% CI=103-331). When evaluated by smaller time periods, males experienced elevations in this cancer in both time periods where females experienced an elevation in this cancer only during the years 1987-1992. Although elevations were observed in both of the smaller time periods, the increases were based on a small number of cases (i.e., three cases or less).

Available smoking data revealed that for those individuals with a known smoking status approximately 56% (n=5) were a current or former smoker at the time of diagnosis and 44% (n=4) reported that they had never smoked. Smoking status was unknown for 31% (n=4) of the individuals. Occupational information was unknown for 38% (n=5) of the individuals diagnosed with kidney cancer in CT 3826. Among the individuals for which occupational information was available, none of the information (i.e., job title or industry type) available for these individuals suggested an occupation that was associated with a risk of developing this disease (Schottenfeld and Fraumeni 1996).

Liver cancer occurred at the expected rate during the period 1982-1992. One case occurred among females during this time period.

Lung cancer was elevated overall and in each of the sexes during the eleven year period 1982-1992 and the later time period 1987-1992. None of the elevations was statistically significant. Males experienced less lung cancer than expected during 1982-1986.

Pancreatic cancer occurred less often than expected during the 1982-1992 time period. No cases occurred during the earlier time period. A small increase among females was observed during the later time period, 1987-1992. The increase was based on approximately one excess case.

Stomach cancer occurred generally less often than expected during 1982-1992. Females experienced stomach cancer at approximately the expected rate.

Hodgkin's disease occurred slightly more often than expected overall. However during the smaller time periods the incidence of this cancer occurred at a rate approximately equal to what would be expected.

Overall, the incidence of NHL was slightly elevated, resulting in an increase of less than two cases as compared to approximately 11 cases expected among males and females combined. Males experienced less NHL than expected in each of the three time periods. In contrast however, females experienced a statistically significant elevation during the later time period 1987-1992. Eight cases occurred where three cases were expected (SIR=267; 95% CI=115-527).

The available occupational information for females diagnosed with NHL in CT 3826 during the period 1987-1992 did not indicate any occupations in which exposures have been related to NHL (i.e., pesticide and organic solvent exposures) (Schottenfeld and Fraumeni 1996). However, occupational information was unknown for four of the eight individuals with NHL in this census tract. NHL occurred less often among females than expected during the earlier time period.

Leukemia occurred generally less often or equal to what would be expected during all three time periods evaluated among both males and females.

D. Geographic Distribution

Place of residence at the time of diagnosis was mapped for all cancer types to assess any possible geographic concentration of cases. In addition to determining census-tract-specific incidence ratios for each cancer type, a qualitative evaluation was conducted to determine whether any specific cancer type appeared to be concentrated in some area(s) within each census tract.

With one exception, there were no concentrations of any specific cancer type within any census tract that was not likely attributed to the presence of a multi-unit complex, a nursing home, or more densely populated areas within the census tracts.

Pancreatic cancer was elevated in the town of Natick and statistically elevated in CT 3821. While the cases appeared evenly distributed throughout CTs 3822-3826 in the town, the geographic distribution of pancreatic cancer in CT 3821 showed that eight of the ten reported cases occurred in close proximity (i.e., less than 0.75 miles) to one another in one area of the census tract. Six of these eight cases are located within a 0.25 mile radius in the residential neighborhood known as the Wethersfield area. All of the six cases in the Wethersfield area were diagnosed during the years 1982-1987.

Although females in CT 3823 experienced a statistically significant elevation in leukemia during 1982-1986, none of the cases occurred in close proximity to one another and were widely distributed throughout the census tract. Bladder cancer was also statistically significantly elevated in CT 3823, due primarily to a significant

elevation among males during 1987-1992. Some cases did appear to be located in closer proximity to one another in the northwest portion of the census tract. However, this area is the center of town and has a high population density. Also, no unusual pattern was observed among these cases with respect to year of diagnosis. In all other Natick census tracts bladder cancer cases appear evenly distributed.

Kidney cancer cases were evenly distributed geographically throughout the town of Natick, including cases in CT 3826 where a significant elevation was observed in this cancer type during the 1982-1992 period. CT 3826 also experienced a significant elevation in NHL among females during 1987-1992. However, no unusual geographic pattern was observed among these cases.

In addition, concerns have been raised regarding suspected increases in cancer incidence specifically in the neighborhoods of Chester Street (CT 3823), Evergreen Road (CT 3825), Lanes End Road (CT 3826) and the Russell Circle/Liberty Street area in the Wethersfield section of Natick (CT 3821). With the exception of pancreatic cancer, evaluation of the geographic distribution of cancer cases in these areas during the eleven years 1982-1992 showed no concentration of any other cancer type. The types of cancers that did occur in these neighborhoods were of various types and displayed no unusual pattern with respect to age, year of diagnosis, or gender. Other than the distribution of pancreatic cancer cases in CT 3821 discussed previously, there was no unusual pattern in the Wethersfield area including Russell Circle and Liberty Street. Also, there was no unusual concentration of cancer cases in the area of Natick Laboratories (CT 3825) (see Figure 2).

E. Smoking Status

Smoking is the most important known risk factor for cancers of the lung, bladder, kidney and pancreas. The smoking status of individuals in Natick diagnosed with these cancers during the years 1982-1992 was reviewed. As shown in Figure 3A, the percentage of individuals in Natick reported as current or former smokers was higher than the percentage reported as never smoked for each of these cancer types. These numbers were comparable to the percentage of current and former smokers among individuals diagnosed with these types of cancer in the state. The distribution of smoking status for bladder and kidney cancer among individuals in Natick and the state as a whole were nearly equivalent. There was a greater proportion of current or former smokers among individuals diagnosed with lung cancer in the state than in the town of Natick (see Figure 3B).

However, these results should be interpreted with caution as the percent of individuals for which smoking status was unknown ranged between 20% and 37% in Natick, versus 11% to 23% in the state. For example, among individuals diagnosed with pancreatic cancer in Natick, smoking status was unknown for nearly 40% of individuals as compared to only 23% unknown in Massachusetts. If nine of the 15 individuals in Natick with unknown smoking status were indeed smokers (i.e., unknown smoking

status is 23%), the percent of smokers would increase from 39% to 61%, thereby indicating the instability of the Natick numbers. Although smoking likely played some role in these cancers, due to the number of individuals with unknown smoking status, it is not clear as to the extent of this role.

Figures 4A and 4B present the distribution of cases with a known smoking status for each of the four cancer types evaluated in Natick and the state. For each cancer type in both Natick and the state there were a greater number of current or former smokers than individuals who reported never smoking. For cancers of the lung and bladder, the majority of individuals were current or former smokers (i.e., 92% and 66%, respectively, for both Natick and the state). Comparison of smoking status for kidney cancer in Natick and the state showed that the percent of current or former smokers in Natick was slightly less than for the state, but there was a greater percent of current or former smokers among individuals diagnosed with pancreatic cancer in Natick as compared to the state.

F. Occupation

A variety of occupational exposures are either suspected or known to be associated with the development of specific types of cancer. Occupation as reported to the MCR at the time of diagnosis was reviewed for cancer cases of the bladder, lung, pancreas and kidney as well as leukemia. The majority of cases reported occupation as "retired" or "at home". The occupational data are incomplete and do not include specific job-duty information that could further define exposure potential. Thus, it could not be determined what role occupation may have played in the development of these cancers.

IV. ENVIRONMENTAL CONCERNS IN NATICK

A. Hazardous Waste Sites

The most recent information regarding sites located in the town of Natick and listed by the Massachusetts Department of Environmental Protection (MDEP) was reviewed. The MDEP is responsible for the monitoring, assessment and clean-up of releases of oil and hazardous materials at disposal sites (subsequently named 21E sites) in Massachusetts. These sites are regulated under Massachusetts General Laws, Chapter 21E.

A total of 57 sites located in Natick were identified by the MDEP as Confirmed Disposal Sites or Locations to be Investigated (LTBI) during the years 1987-1993 (MDEP 1995). The status of four of these sites was subsequently modified to indicate that the location was not a disposal site or did not currently require further remedial response actions. Of the remaining sites, 10 are listed as Confirmed, 32 are listed as LTBI and 11 sites have Waiver status. In addition, the Natick Laboratories site accounted for two of the Confirmed sites in Natick. (Confirmed status is a location confirmed by the MDEP to be a disposal site, and for which remedial response actions

have not been completed. Waiver status are locations confirmed by the MDEP to be non-priority disposal sites, and where an interested party has been authorized to proceed with response actions without MDEP oversight. LTBIs are locations the MDEP considers reasonably likely to be disposal sites but are as yet unconfirmed.) There was no unusual pattern or concentration of cancer types in Natick in relation to Confirmed disposal sites or LTBI listed by the MDEP. Refer to Figure 5 for the location of MDEP 21E sites.

B. The Maffei Property

The Maffei property is located on Wellesley Road Extension in the northeast portion of the town of Natick (see Figure 2). The site is an undeveloped piece of land that is surrounded by residential properties to the north, south and west. The eastern portion of the property is bounded by a wetlands area which drains southeasterly toward Morses Pond, located approximately 0.5 mile from the site. The Cochituate Aqueduct, which supplies the Massachusetts Water Resource Authority (MWRA), is located beyond the wetlands area .

Although the Maffei property has consisted of undeveloped land for approximately 30 years, historically the site has been filled with various materials in order to raise the grade of the property for future development. Concerns regarding the Maffei property have focused on the nature and extent of the fill materials used and possible contamination of the property that may have resulted from the use of the fill (SET 1996). In addition, residents in the area have raised concern regarding increased cancer incidence in the neighborhood surrounding the property.

An initial subsurface investigation was performed at the site in November 1994. Excavation of 11 test pits at the site revealed oil-contaminated soils in several areas on the property. Laboratory analyses of soil samples collected from the test pits detected 112 parts per million (ppm) lead on the eastern portion of the property and total petroleum hydrocarbons (TPH) resembling # 6 fuel oil ranging in concentration from 96 to 1,500 ppm in soil across the site. Groundwater samples contained lead in concentrations of 0.007 to 69 ppm and TPH at 2.9 to 4.5 ppm. The MDEP subsequently designated the site as an Unconfirmed disposal site in March 1995 (RTN# 3-12230) (SET 1996).

Further subsurface investigation at the property in March through September 1995 detected three areas of oil-contaminated soil. TPH (970 ppm), lead (1,108 ppm) and semi-volatile organic compounds (SVOCs) at concentrations ranging from 1.61 to 3.26 ppm were detected in soils below six feet on the western portion of the property (SET 1996). On the eastern portion of the property, TPH was detected at a concentration of 29,000 ppm. More recently, polychlorinated biphenyl's (PCBs) were detected in soils that were stockpiled on the property and intended for removal. Based on groundwater sampling at the site, it is suspected that the PCBs are located at the base of

the fill, and 2 to 15 feet beneath the surface. No PCBs have been detected in surface soils (0-6 inches) at the site (SET 1997).

The Maffei property is located near the Wellesley town border in CT 3821. Evaluation of the geographic distribution of cancer cases in this census tract revealed no apparent clustering or unusual concentration of any one cancer type within the area surrounding this site. The types of cancers that were observed in the area of the site were different primary site cancers. In addition, the types of contaminants detected at the Maffei property have not been associated with the development of any of the cancer types that occurred among individuals in this area during the period 1982-1992. Based on the types and geographic distribution of cancer cases in the area, it does not appear that the Maffei property is related to any unusual increase of cancer in the surrounding neighborhood.

C. Underground Storage Tanks (USTs)

In Natick, many of the homes, particularly in the Wethersfield neighborhood, are "slab" style construction, a common building style of the 1940s and 1950s. Slab style homes are single story homes built without a basement or cellar storage. As a result, tanks used for heating oil (fuel oil #2) were frequently buried underground on the property (Whitman and Howard 1995a). Underground storage tanks (USTs) that were constructed during the 1940s-1960s were typically 275-500 gallons in capacity consisting of a single layer of steel that often leaked over time due to corrosion and pitting of the steel.

Property records in Natick indicated that as many as 800 homes in the town had USTs (Whitman and Howard 1995a). A survey of these properties indicated that there were approximately 400 aging USTs. Moreover, previous UST removals and excavations from over 100 Natick homes during 1991-1993 indicated that 45% of these tanks were likely to have been leaking.

In 1993, the town of Natick contracted the engineering firm of Whitman & Howard, Inc. to address the UST removals by conducting the Residential Underground Storage Tank (RUST) Program. UST and soil removal and remediation began during April 1994 and were completed by the end of 1994. Removal and remediation were performed in three phases. In phase I, all the USTs were pumped of residual fuel, removed and disposed. If the tank was not leaking, the excavation was backfilled and the landscaping restored. However, if a tank was found to be leaking, then the property entered phase-II of the project. In phase-II, petroleum contaminated soil was excavated and treated, and additional response actions were performed as required. Contaminated soil generated during phase-II was sent to a permitted thermal treatment facility located in New Hampshire (Whitman & Howard 1995a).

In summary, 320 USTs were removed or abandoned in place in Natick. Of these, 176 USTs showed no evidence of leaking and were removed or abandoned in place with no further remedial activities required. The remaining 144 USTs (45%) displayed some

evidence of leaking and required phase-II excavation and remediation activities. Of these, contaminated soil was excavated and treated for 112 sites. Thirty-two sites required further investigation and remediation (i.e., phase-III) mostly due to soil contamination beneath the home (sub-slab). Currently, of the 32 phase-III sites, 24 have been remediated, seven have been remediated with an Activity and Use Limitation, and one site has continued remediation activities.

A risk assessment indicated TPH concentrations of up to 4,000 ppm in soil beneath the slab constitutes a condition of "No Significant Risk", based on the following assumptions:

- Thirty years of possible exposure to inhalation of vapors that could enter the home from beneath the slab, and
- Thirty years of ingestion and dermal exposure, in the event the home were demolished and the contaminated soil brought to the surface.
- The 4,000 ppm applies to homes of slab-on-grade construction and sites where there is no groundwater contamination (Whitman & Howard 1995b).

In the Wethersfield area, approximately 202 USTs were removed or abandoned in place. More than half of these USTs (i.e., 104) showed no evidence of leaking and were removed or abandoned in place with no further remedial activities required. The remaining 98 USTs required phase-II excavation and remediation activities. Of these, contaminated soil was excavated and treated (phase-II) for 92 sites; five sites were remediated with Activity and Use Limitations (AUL) due to sub-slab contamination; and one site has on-going remediation activities.

The locations of UST removals in this project were compared to residence at the time of diagnosis for the ten pancreatic cancer cases that occurred in census tract 3821 during 1982-1992. Of these ten cases, UST removal activities occurred at the residence of five of the cases and for the other five cases there were no files or information indicating UST removal activities at the residence. Of the five cases with UST removal activities, three went through phases I & II of the UST removal project and no further remedial action is required (a closed site). At one property, the UST had been removed by the property owner before the RUST Project began. The residence of the fifth case experienced sub-slab contamination, requiring phase-III activities of further investigation and remediation.

D. Drinking Water Supply

Town water officials report that the municipal supply in Natick is currently in compliance with all applicable regulatory requirements. Concern has been raised in Natick regarding past contamination of some of the municipal wells that supply drinking water to the town and possible associations with cancer incidence. The MDPH/BEHA has requested technical assistance from the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate the historical quality of drinking water in Natick and in learning more about the water distribution system.

V. DISCUSSION

Overall and among males, cancer incidence occurred at or below expected rates in the town of Natick as a whole during the period 1982-1992, while females experienced generally greater than expected rates of cancer during this time. Although elevations were observed among females in the town, there were no statistically significant elevations of any of the eleven cancer types evaluated. However, a number of cancer types were statistically significantly elevated in certain census tracts within Natick. With the exception of pancreatic cancer in CT 3821, there was no consistent pattern in the type of cancer elevated with respect to gender or time period in which the elevation occurred. The types of cancer that were significantly elevated in Natick and evidence regarding risk factors that may have contributed to these elevations are discussed below.

A. Pancreatic Cancer

Pancreatic cancer is a relatively uncommon disease that accounts for approximately 5% of all cancer deaths annually. There are currently no safe and effective means of early diagnosis. Median survival with pancreatic cancer is approximately three months with less than one chance in five of surviving one year (Schottenfeld and Fraumeni 1996). The age-adjusted incidence rate per 100,000 in the United States during 1989 was 8.7 which was slightly higher than the rate in Massachusetts (7.8/100,000) (MDPH 1995b).

The most reliable and important known predictor of pancreatic cancer incidence is age. The majority of cases occur between the ages of 65 and 79 and rarely before age 40. The median age at diagnosis is 71 years. The rate of pancreatic cancer increases with age; individuals age 80 and over experience a risk approximately 40 times greater than individuals between ages 40 to 50. Pancreatic cancer is approximately 50% more common in men than women. However, since 1970, the ratio of male to female has decreased due to declining incidence rates among males (Schottenfeld and Fraumeni 1996).

In CT 3821 in Natick the median age of pancreatic cancer cases was 71.5 with a range of 44 to 82 years. There were five male and five female cases in this census tract during the period 1982-1992. Thus, the ratio of male to female cases was 1:1. The ratio of male to female cases in the town of Natick as a whole was also nearly equal and no increase or decrease was observed throughout the 11 years 1982-1992. During both time periods 1982-1986 and 1987-1992 the ratio of male to female cases was nearly equal.

Little is known about the etiology of pancreatic cancer. Cigarette smoking is the only established risk factor in the development of this disease. Studies have estimated that the risk of pancreatic cancer is two to six times greater in heavy smokers than in non-smokers (NCI 1996, Schottenfeld and Fraumeni 1996).

Because cigarette smoking is a known risk factor for pancreatic cancer, the smoking status of each of the cases was examined. The available smoking status information for pancreatic cancer cases in CT 3821 revealed that three individuals reported a smoking status as current or former smoker, four individuals reported having never smoked and smoking status was unknown for three individuals. While it is possible that cigarette smoking may have played a role in the development of pancreatic cancer among some of these individuals, it is not clear as to the extent that cigarette smoking contributed to the significant elevation in this census tract.

Although there are no common occupations that can be considered as causes of pancreatic cancer, associations have been suggested with products of incomplete combustion, certain pesticides such as DDT, and to other chemicals (i.e., methylene chloride) or chemical processes such as film manufacturing and leather tanning (Schottenfeld and Fraumeni 1996).

Other factors have been suggested to be associated with the development of pancreatic cancer, though the evidence is unclear. These factors include hereditary factors and medical conditions such as diabetes mellitus and chronic pancreatitis (NCI 1996, Schottenfeld and Fraumeni 1996).

Pancreatic cancer was significantly elevated in CT 3821 during the entire 1982-1992 period. This elevation can be largely attributed to an increased incidence during the earlier time period 1982-1986 (see Figure 6). During 1987-1992 the pancreatic cancer incidence in CT 3821 was about as expected. The MDPH/BEHA is currently conducting interviews with the next-of-kin of individuals diagnosed with pancreatic cancer and a resident of Natick during 1982-1992 in order to further investigate factors that may be related to the incidence of this cancer in Natick, particularly in CT 3821.

B. Bladder Cancer

In CT 3823, a statistically significant elevation in bladder cancer occurred overall and among males during the later time period 1987-1992. However, the geographic distribution of cases in this census tract revealed no unusual pattern or concentration of cases.

Cancer of the bladder occurs primarily among white men and the male to female ratio is approximately three to one among most racial groups but four to one among whites (Schottenfeld and Fraumeni 1996). The incidence of bladder cancer increases with age, with the majority of cases occurring at average ages of 68 years among men and 69 years among women (ACS 1995).

Epidemiologic studies have implicated three risk factors associated with bladder cancer: tobacco smoking, occupation, and parasitic infection. However, cigarette smoking is known to be the principal causative factor in the development of bladder cancer, with smokers experiencing two to three times the risk of non-smokers. Smoking

is estimated to be responsible for approximately 47% of the bladder cancer deaths among men and 37% among women (ACS 1995).

Occupations associated with a high risk of developing bladder cancer include workers in the dyestuffs and rubber industries, due to exposure to aromatic amines, most notably benzidine and 2-naphthylamine (NCI 1996; Schottenfeld and Fraumeni 1996). An increased risk of bladder cancer has also been noted among painters, and workers in the leather, metal, and textile industries (ACS 1996, Schottenfeld and Fraumeni 1996). Other bladder cancer risk factors that have been implicated in epidemiological studies include residence in urban areas, chronic bladder inflammation, and metabolites of certain foods (ACS 1996).

Although a statistically significant elevation occurred in this cancer type in CT 3823, there was no unusual pattern observed among these individuals. The elevation occurred among males, and the majority of cases (i.e., 67%) were greater than age 70 at the time of diagnosis. The age range of the cases was 59 to 92 years. In addition, seven of the nine men diagnosed with bladder cancer during this time period were current or former smokers. One individual reported a smoking status as never smoked and for one individual smoking status was unknown. Based on this information, it is likely that cigarette smoking contributed to the increased incidence in this census tract.

C. Leukemia

Leukemia literally means "white blood cell"; a reference to the excessive numbers of white blood cells or leukocytes in the peripheral blood of individuals diagnosed with leukemia. The serious symptoms of the disease, however, are caused by a lack of normally functioning cells and/or platelets. This deficiency is brought about through the proliferation of cells that resemble a stage in normal blood cell development but are incapable of performing the functions of mature blood cells (Miller et al. 1990, Clarkson 1980). These functions include fighting off foreign invaders to the body by attacking them or releasing harmful substances.

Leukemia is an umbrella term representing a group of cancers involving cells of blood-forming organs. There are four major subtypes into which most histologic types of leukemia can be categorized: acute lymphoid leukemia (ALL); chronic lymphoid leukemia (CLL); chronic myeloid leukemia (CML); and acute myeloid leukemia (AML). Epidemiological research over the past twenty-five years has revealed patterns of incidence and risk factors which vary for each subtype. While there are known and suspected risk factors for each subtype, leukemia cases are relatively rare, and despite a large body of research, risk factors that have been identified for different leukemia subtypes only account for a small percentage of cases (Linet 1985).

ALL occurs predominantly in children. Incidence rates drop off among middle aged people, and increase again among older individuals (ACS 1995). The known risk factors for ALL are ionizing radiation and benzene exposure. Suspected risk factors are

genetic, viral, environmental, and occupational. Studies indicate that acute leukemias (ALL and AML) occur at an increased rate in a variety of congenital disorders including Down syndrome and Klinefelter syndrome (Scheinberg and Golde 1994). Other research has supported viral factors. However, a specific viral agent has not been identified. An increased risk of childhood ALL has been associated with exposure to several chemicals and possible paternal occupational exposure to hydrocarbons (Linet 1985).

CLL is chiefly an adult disease; 90% of cases occur in people over 50 years old. CLL is the most common type of leukemia in the United States and occurs more often in males than females (Miller et al. 1990). Adult T cell leukemia is a type of CLL caused by a virus, Human T-Cell Leukemia/Lymphoma Virus-I (HTLV-I). The only known risk factor for other types of CLL is exposure to benzene. No association has been found between CLL and exposure to ionizing radiation. Studies showing strong patterns of incidence in families suggest a genetic etiology. An association between CLL and autoimmune diseases suggests that immunologic factors may play an important role. Several viruses linked with leukemia in animals have been shown to cross species barriers; research suggests that human proximity to sick farm animals and pets may increase the risk of CLL. Rubber workers, and particularly tire builders, have a higher incidence of CLL. Exposure to some chemical wastes in the environment may also be a risk factor (Linet 1985, Scheinberg and Golde 1994, Schottenfeld and Fraumeni 1996).

AML may occur in children up to the age of 19, with incidence increasing rapidly beyond age 20. The known risk factors for AML are similar to those for ALL: exposure to ionizing radiation and benzene. Recent studies suggest that viral and genetic factors play a less important role in the development of AML than in ALL and CLL. Suspected risk factors for AML include occupational and environmental exposures and certain drug therapies, such as chloramphenicol and phenylbutazone. Suspected chemical exposures include petroleum products and organic solvents. AML as a secondary malignancy is increasing among people who have previously had non-Hodgkin's lymphoma, multiple myeloma, breast cancer, ovarian cancer, and lung cancer. A high risk of secondary AML in people who have had Hodgkin's lymphoma has also been documented. The question remains whether secondary AML is a result of chemotherapy and/or radiation treatment for a previous cancer, or whether secondary AML occurs as part of the natural history of the previous cancer because improved cancer therapy may have lengthened survival time. Cigarette smoking has been identified as a possible risk factor in the development of AML (Linet 1985, Siegel 1993).

Of all the leukemias, CML is among the least understood. CML is an acquired genetic disorder, characterized by the presence of the Philadelphia chromosome. CML can occur at any age, but is most often observed in people between 30-50 years old. The only known risk factor is exposure to ionizing radiation, based on studies of atomic bomb survivors. Occupational exposure to benzene has also been associated with the development of CML, however a causal relationship has not been established. Exposure to other chemical agents in the work place or environment is suspected in this disease. Cigarette smoking is also suspected in the development of CML, however the association

is weak at best. Current research has suggested that heredity and immunologic factors do not appear to be important in the development of CML (Golde and Gulati 1994, Linet 1985, Siegel 1993).

Lymphosarcoma cell leukemia is uncommon. Immunologic factors are suspected in the development of this type of leukemia (Linet 1985).

The incidence of leukemia in females was statistically significantly elevated in CT 3823, during the earlier time period 1982-1986. It is important to note, however, that the cases were various histologic types of leukemia and were widely dispersed geographically throughout the census tract. Because the leukemias were of varied histologic types, which have different risk factors, no single factor is likely to explain the elevation of leukemia in this census tract.

D. Kidney Cancer

Kidney tumors involve renal cell cancers (the main area of the kidney), renal pelvis cancers (lower kidney area which collects urine), and ureter cancers (tube conducting urine from kidney to the bladder) and urethera cancers (leading from the bladder and discharging urine). The incidence and mortality from kidney cancer is higher in urban areas, which may be due to increased access to screening and other factors. Kidney cancer is more common among males than females and incidence most often occurs in the fifth and sixth decades (50-70 year age group) (ACS 1996).

Similar risk factors have been associated with the different kidney cancer cell types. Cigarette smoking and use of tobacco products are the most important known risk factors for kidney cancer, however the risk of developing kidney cancer declines significantly corresponding to years of cessation (LaVecchia et al. 1990). An association with passive smoking has also been investigated as a risk factor. Body weight and obesity, especially in women, is also a risk factor in renal cell carcinoma. Researchers suspect that this may be related to the excess estrogen levels commonly observed in female obesity. In addition, diuretic use and antihypertensive medications are also associated with increased risk of renal cell carcinoma. A diet high in protein (animal fats, milk products, margarine and oils) has been implicated in epidemiologic studies as a risk factor for renal cell carcinoma. Long-term use of pain relievers such as phenacetin (and possibly acetaminophen and aspirin) increase the risk for cancer of the renal pelvis and renal cell carcinoma. An association has been established between the incidence of von Hippel-Lindau disease in families and the development of renal cell carcinoma, which suggests a genetic factor (Schottenfeld and Fraumeni 1996).

Occupational exposure risk factors have not generally been identified as risk factors for kidney cancer. However, studies of insulation workers and asbestos products workers (mostly shipyard workers) have shown some association (NCI 1996, Schottenfeld and Fraumeni 1996).

In CT 3826, where a significant elevation was observed among males and females combined, the majority of cases occurred among men in their late 60s. It should also be noted that more than 50% of the individuals diagnosed with kidney cancer in this census tract were current or former smokers which may have contributed to the increase observed in this area of town.

E. Non-Hodgkin's Lymphoma (NHL)

Lymphomas are cancers involving the white blood cells of the immune system, which usually fight infection (Schottenfeld and Fraumeni 1996). Non-Hodgkin's lymphoma (NHL) is a classification of all lymphomas with the exclusion of Hodgkin's disease. NHL occurs at all ages, however the incidence of NHL generally increases with age. Among all NHL types combined there is a greater male to female ratio, and white to black ratio.

The incidence of NHL has been markedly increasing over time. Based on the rate of increase for all cancers, NHL ranks third among males and among females (Schottenfeld and Fraumeni 1996). NHL is more common among people who have abnormal or compromised immune systems, such as those with inherited immunodeficiency diseases, organ transplant recipients, and persons with autoimmune disorders such as systemic lupus erythematosus, Sjogren's syndrome, and rheumatoid arthritis. Chronic stimulation of antigens appear to compromise control of latent infections and these factors increase the risk of developing NHL. Several viruses have also been linked to increased risk of some NHL subtypes, chiefly the HTLV-1 virus and the Epstein-Barr virus (Schottenfeld and Fraumeni 1996).

Recent epidemiologic studies of users of long-term dark color hair dye products have found increased incidence of NHL development. Occupational exposures to organic solvents have been associated with increased risk of developing NHL and include workers in the chemical and agriculture industries, particularly among farmers, herbicide and pesticide appliers, and grain workers. Chemicals found to be associated include phenoxy herbicides and organophosphate insecticides and chlorophenols (Schottenfeld and Fraumeni 1996). Elevated risk for NHL development has been noted among fence workers, orchard workers, and meat workers.

AIDS patients in particular have exhibited excessive NHL incidence (ACS 1996). The HTLV-1 virus has been associated with adult T-cell lymphoma incidence in the Southeastern United States, and the Epstein-Barr virus is strongly associated with African Burkitt's lymphoma. Previous chemotherapy combined with radiation has been associated with the development of NHL. Ionizing radiation has induced lymphomas in animals. One study of Japanese atomic bomb survivors found an elevation of NHL in persons who were under 25 years of age at exposure; however, this excess did not appear until 14 to 16 years after exposure. Certain therapeutic radiation treatments have also been associated with the development of NHL (ACS 1996, Freedman and Nadler 1994, Schottenfeld and Fraumeni 1996).

Several chemicals are suspected in the etiology of NHL, particularly combined exposures. Some of these agents include phenoxy acids, chlorophenols, organic solvents, pesticides, and herbicides; however, there is no consistent evidence and causal associations have not been established (Higginson, et al. 1992). Certain industrial and chemical exposures (e.g., rubber workers, oil refining industry) have been associated with NHL.

The incidence of NHL was statistically significantly elevated among females in CT 3826 during 1987-1992. The available occupational information for females diagnosed with NHL in CT 3826 during this period did not indicate any occupations in which exposures have been related to this disease. NHL occurred at lower than expected rates among females during the earlier time period and among males during all time periods examined for CT 3826. It is important to stress that no unusual geographic pattern was observed among these cases.

VI. LIMITATIONS

This assessment is a preliminary investigation which analyzes descriptive health outcome data to determine whether the occurrence of selected cancers is unusual. Information from such descriptive analyses, which may suggest that a common etiology is possible, can serve to identify areas where further public health actions or investigations may be warranted. Limitations in the available data make it impossible to determine the precise causal relationships or synergistic roles that may have played a part in the development of any cancers in this community.

VII. CONCLUSIONS

- Overall and among males, cancer incidence occurred at or below expected rates in the town of Natick as a whole during the period 1982-1992, while females experienced generally slightly higher rates of cancer than expected during this time. Although elevations were observed among females in the town, there were no statistically significant elevations of any of the eleven cancer types evaluated.

- The available data do not show a common pattern that would suggest that any single risk factor is likely to be responsible for the pattern of cancer incidence in Natick during the period 1982-1992. However, a number of cancer types were statistically significantly elevated in certain census tracts within Natick. With the exception of pancreatic cancer in CT 3821, there was no consistent pattern in the type of cancer elevated with respect to gender or time period in which the elevation occurred.

- Pancreatic cancer was statistically significantly elevated in CT 3821. The elevation occurred in the earlier time period, 1982-1986 and although the number of cases that occurred among each sex was less than five, the incidence was greater than expected in both males and females separately. Furthermore, pancreatic cancer in CT 3821

appeared geographically concentrated in a residential area known as Wethersfield. The available information on smoking status and occupation did not suggest that these two factors were likely to account for the observed increase. However, the data were incomplete for a number of individuals and limited for those where information was available.

- A statistically significant elevation occurred in bladder cancer among males in CT 3823 during 1987-1992. However, further evaluation of these cases revealed there was no unusual geographic pattern observed among these individuals. The majority of cases (i.e., 67%) were greater than age 70 at the time of diagnosis and were current or former smokers. Only one individual reported a smoking status as never smoked. Based on this information, it is likely that cigarette smoking contributed to the increased incidence in this census tract.

- A statistically significant elevation in leukemia occurred in CT 3823 among females during the period 1982-1986. The cases were various histologic types of leukemia (each with different characteristics and risk factors) and no clustering of cases was evident. The cases were widely dispersed geographically throughout the census tract. Leukemia in females occurred at the expected rate during the later time period in this census tract.

- In CT 3826, a statistically significant elevation was observed in kidney cancer among males and females combined during 1982-1992. The majority of cases occurred among men in their late 60s and more than 50% of the individuals diagnosed with kidney cancer in this census tract were current or former smokers which may have contributed to the increase observed in this area of town.

- NHL was statistically significantly elevated among females in CT 3826 during the later time period 1987-1992. No unusual pattern or geographic concentration of cases was observed in this area of Natick.

- With the exception of pancreatic cancer in CT 3821, there were no concentrations of any specific cancer type within any census tract that was not likely attributed to the presence of a multi-unit complex, a nursing home, or more densely populated areas within the census tracts.

- There was no unusual pattern or concentration of any one cancer type in Natick in relation to Confirmed disposal sites or LTBI listed by the MDEP.

- Based on the types and geographic distribution of cancer cases in the area, it does not appear that the Maffei property located on the Wellesley border in CT 3821 is related to any unusual increase of cancer in the surrounding neighborhood

VIII. RECOMMENDATIONS

1. The MDPH/BEHA is currently conducting interviews with the next-of-kin of individuals diagnosed with pancreatic cancer during 1982-1992 in order to further investigate factors that may be related to the incidence of this cancer in Natick, particularly in CT 3821.

2. The MDPH/BEHA will further investigate non-Hodgkin's lymphoma cases among females diagnosed during 1987-1992 in CT 3826 by reviewing residential and occupational histories of these individuals.

3. Although the available data do not suggest an increase in cancer incidence in the area surrounding the Maffei property in CT 3821, the MDPH/BEHA will continue to review the environmental data for this site as they become available.

4. Based on data suggesting contamination in the past of some of the municipal wells that supply drinking water to the town of Natick, the MDPH/BEHA has requested technical assistance from the ATSDR to evaluate the historical quality of drinking water in Natick and in learning more about the water distribution system. ATSDR will present its evaluation of this issue in its Public Health Assessment scheduled to be released in May 1997. Due to citizen concerns regarding suspected increases in cancer incidence and a possible relationship to the Natick water supply, upon completion of the ATSDR Public Health Assessment the MDPH/BEHA will review the findings presented in this report on cancer incidence in Natick.

5. The MDPH/BEHA will continue to monitor cancer incidence rates in Natick through the Massachusetts Cancer Registry.

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Figure 1

Location of Census Tracts in Natick, Massachusetts

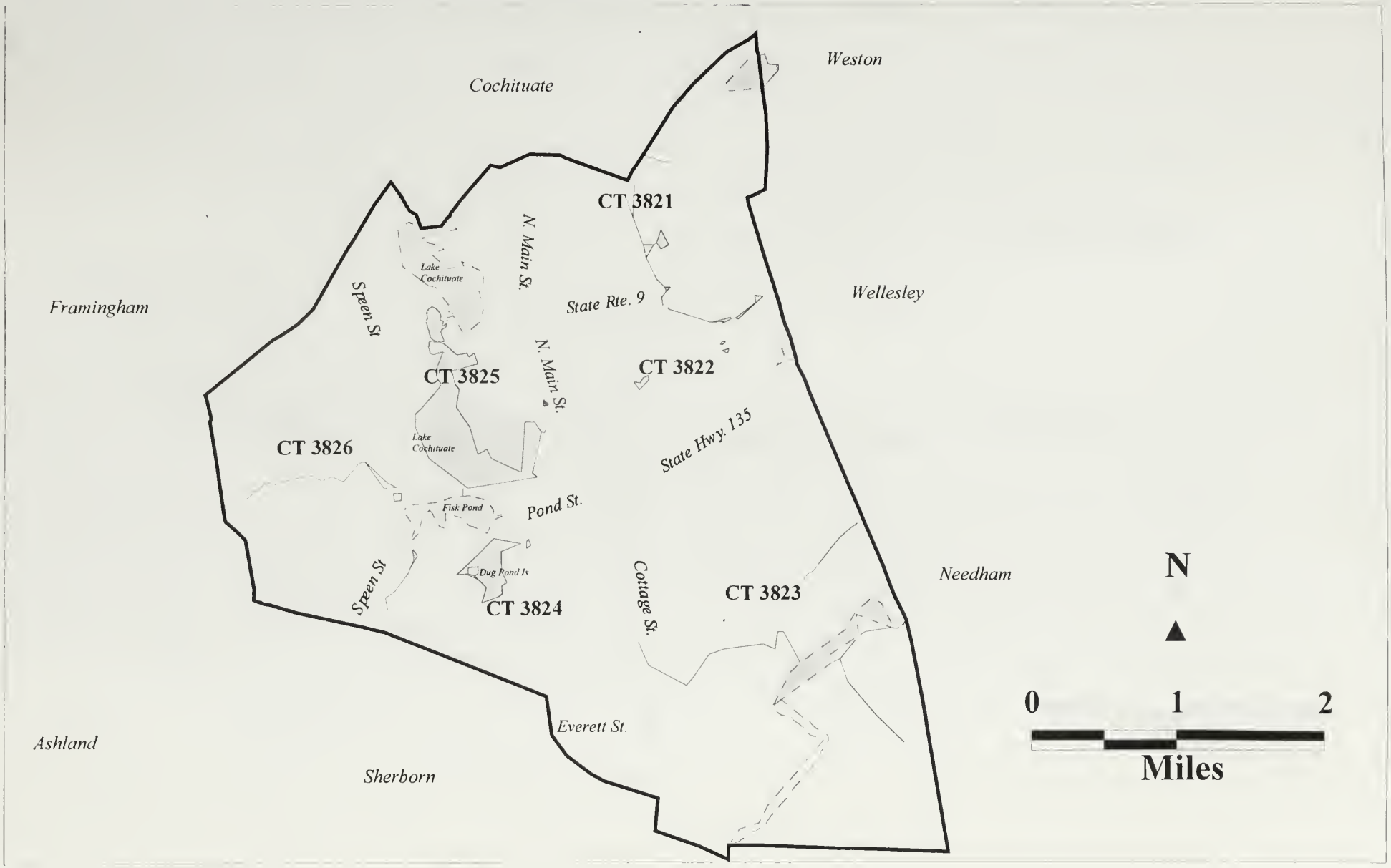

Figure 2

Location of Natick Labs and the Maffei Property

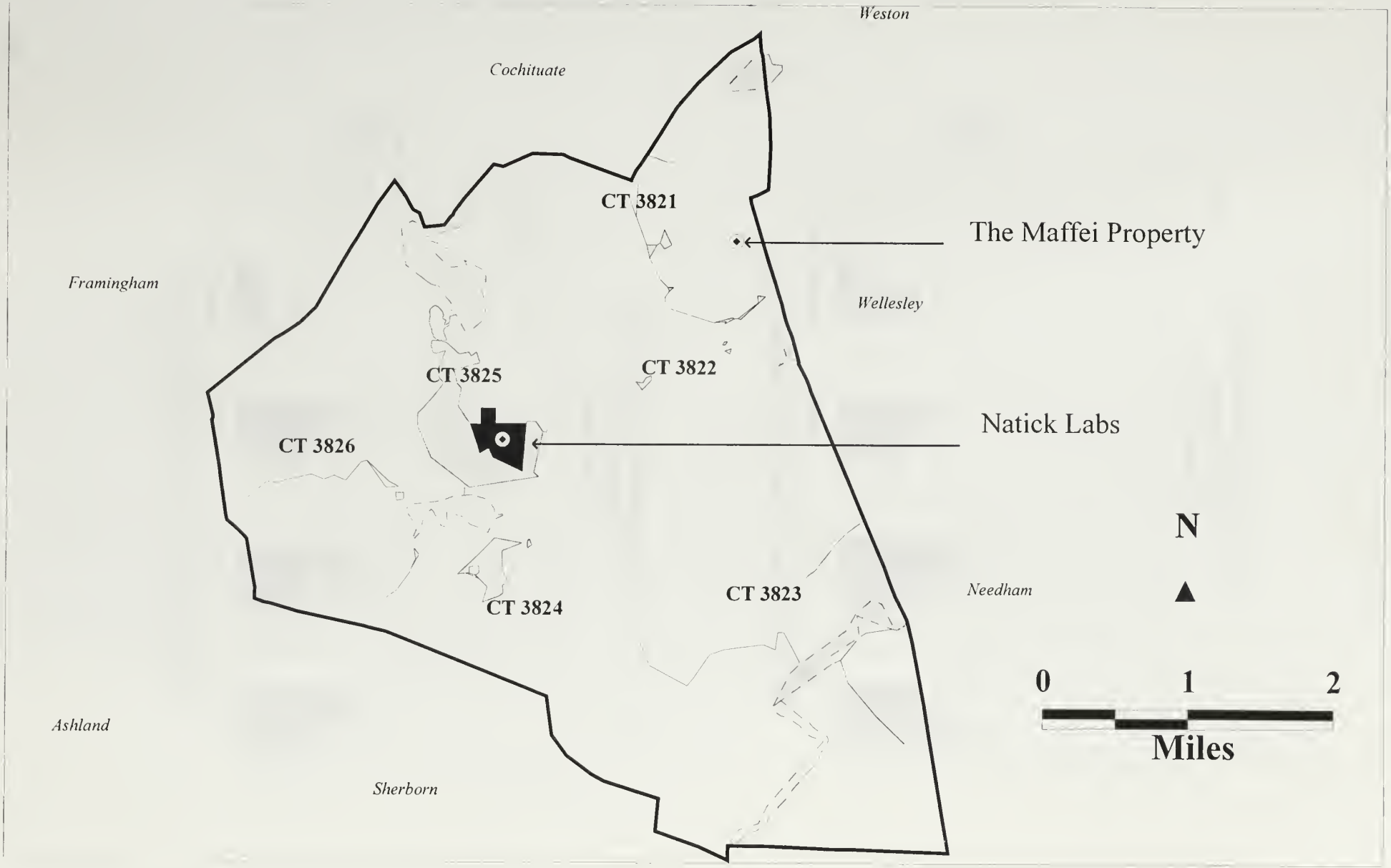

Figure 3A

Smoking Status of Selected Cancers
during 1982-1992
Natick, Massachusetts

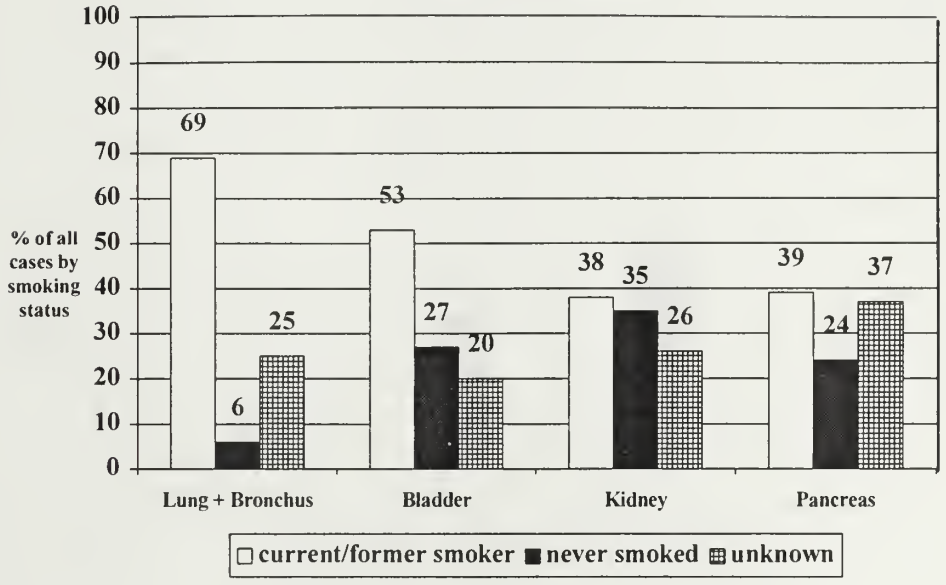

Figure 3B

Smoking Status of Selected Cancers
during 1982-1992
Massachusetts

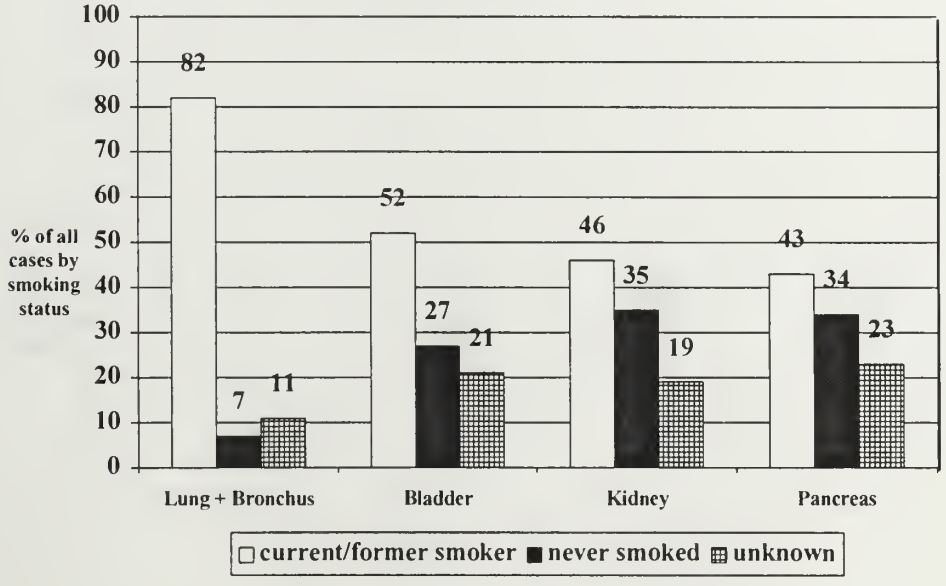

Figure 4A

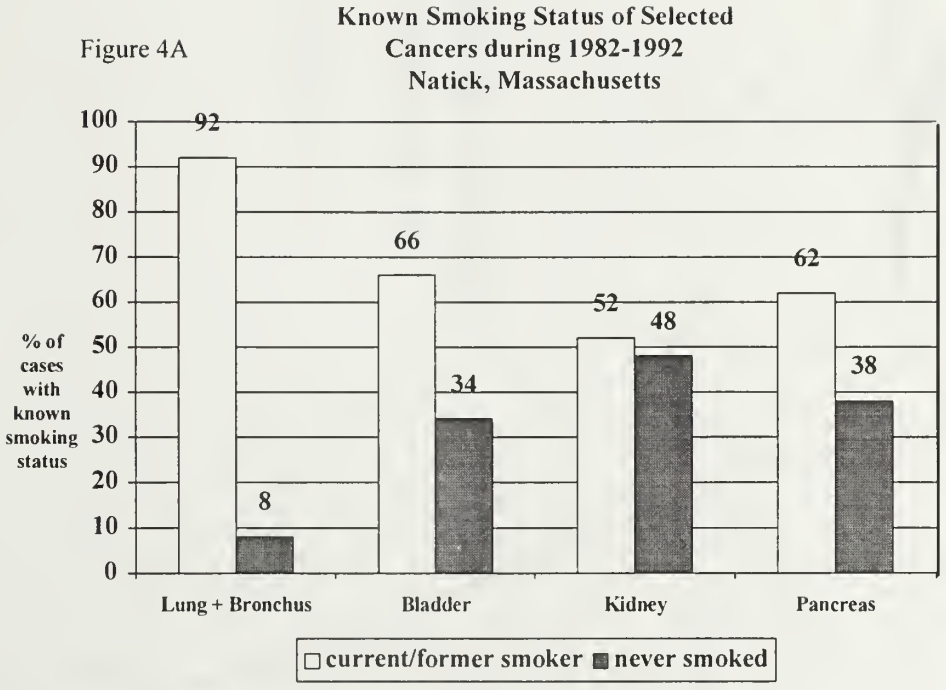

Figure 4B

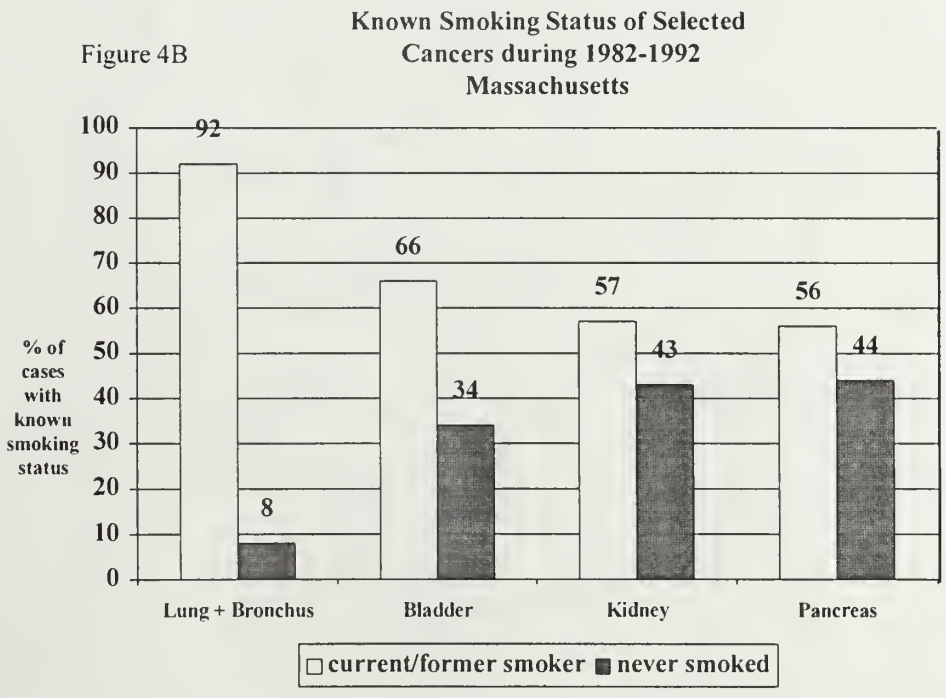

Figure 5

Location of MDEP 21E-sites in Natick, Massachusetts

Figure 6

Annual Distribution of Pancreatic Cancer in Census Tract 3821, Natick, MA 1982-1992

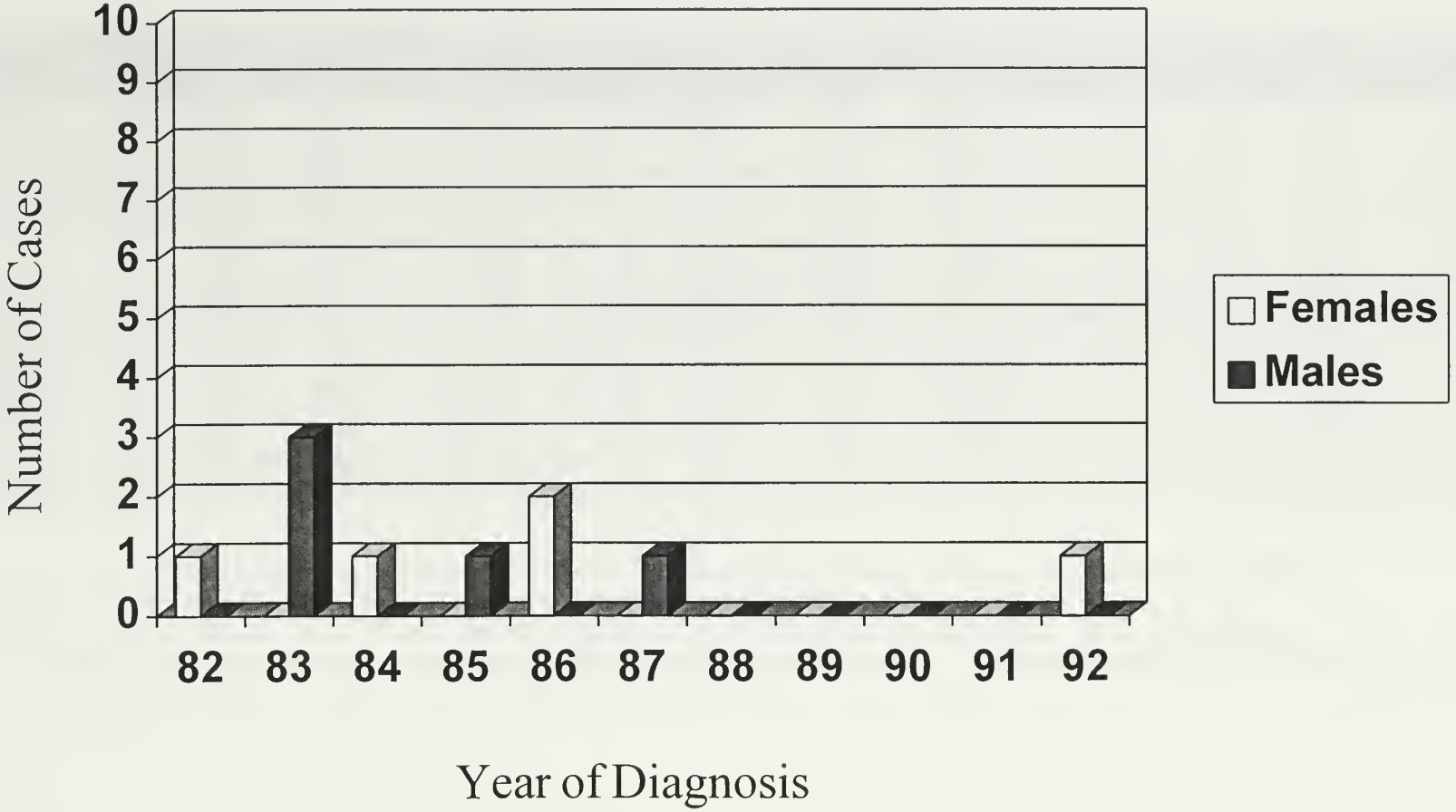

Table 1A

Cancer Incidence in Natick, MA 1982-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	68	61.8	110	85--140	48	44.6	108	79--143	20	17.2	116	71--180
Brain	23	21.3	108	68--162	13	11.5	113	60--193	10	9.8	102	50--188
Breast	258	241.2	106	94--120	1	1.5	NC	NC	257	239.7	107	94--120
Kidney	34	32.0	106	73--148	19	19.4	98	59--153	15	12.7	119	66-196
Liver	5	6.6	75	24--176	2	4.6	NC	NC	3	2.0	NC	NC
Lung	190	200.5	95	82--109	107	123.8	86	71--104	83	76.7	108	81--126
Pancreas	41	30.9	132	95--180	22	14.6	150	94--228	19	16.3	117	70--182
Stomach	25	31.4	79	51--117	10	18.9	53 *	25--97	15	12.5	120	67--197
Hodgkins	13	12.8	101	54--173	10	6.8	147	70--270	3	6.0	50	NC
NHL	49	48.6	101	75--133	23	25.0	92	58--138	26	23.6	110	72--161
Leukemia	25	27.2	92	59--136	8	15.2	53	23--104	17	12.0	142	83--227

Notes:
Expected number of cases presented are rounded to the nearest tenth. SIRs are calculated based on the exact number of expected cases.
SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance ($P < .05$)

Table 1B

Cancer Incidence in Natick, MA 1982-1986 and 1987-1992

1982-1986

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	24	28.0	86	55--127	16	20.1	79	45--129	8	7.8	102	44--201
Brain	12	8.8	136	70--238	9	4.8	187	85--355	3	4.0	NC	NC
Breast	104	98.5	106	86--128	1	0.6	NC	NC	103	98.0	105	86--128
Kidney	12	12.0	100	52--175	9	7.2	125	57--238	3	4.8	NC	NC
Liver	1	2.7	NC	NC	0	1.9	NC	NC	1	0.9	NC	NC
Lung	79	88.0	90	71--112	43	56.9	76	55--102	36	31.1	116	81--160
Pancreas	20	14.5	138	84--213	11	6.8	162	80--289	9	7.7	117	53--222
Stomach	13	15.4	85	45--145	4	9.2	NC	NC	9	6.2	145	66--276
Hodgkins	6	5.8	104	38--225	4	3.2	NC	NC	2	2.6	NC	NC
NHL	18	19.6	92	54--145	8	9.9	81	35--159	10	9.7	104	50--190
Leukemia	14	12.6	111	61--186	6	7.0	86	32--188	8	5.7	141	61--277

1987-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	44	33.7	131	95--176	32	24.3	132	90--186	12	9.3	129	66--224
Brain	11	12.4	88	44--158	4	6.7	NC	NC	7	5.7	121	48--250
Breast	154	142.4	108	92--127	0	0.9	NC	NC	154	141.4	108	92--127
Kidney	22	19.9	110	69--167	10	12.1	82	39--152	12	7.8	154	79--269
Liver	4	3.9	NC	NC	2	2.8	NC	NC	2	1.1	NC	NC
Lung	111	112.2	99	81--119	64	66.7	96	74--123	47	45.5	103	76--137
Pancreas	21	16.4	128	79--195	11	7.8	140	70--251	10	8.6	116	56--214
Stomach	12	16.1	75	39--131	6	9.7	62	23--134	6	6.4	94	34--205
Hodgkins	7	7.0	100	40--206	6	3.6	165	60--359	1	3.3	NC	NC
NHL	31	28.8	108	73--153	15	14.9	100	56--166	16	13.9	115	66--187
Leukemia	11	14.5	76	38--135	2	8.2	NC	NC	9	6.3	143	65--272

Notes:
Expected number of cases presented are rounded to the nearest tenth. SIRs are calculated based on the exact number of expected cases.
SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance ($P < .05$)

Table 2A

Cancer Incidence in Census Tract 3821, Natick, MA 1982-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	6	9.7	62	23--134	4	7.3	NC	NC	2	2.4	NC	NC
Brain	1	3.5	NC	NC	1	1.9	NC	NC	0	1.5	NC	NC
Breast	43	38.0	114	83--154	1	0.2	NC	NC	42	37.3	112	81--152
Kidney	6	5.2	115	42--250	1	3.3	NC	NC	5	2.0	256	82--597
Liver	0	1.1	NC	NC	0	0.8	NC	NC	0	0.3	NC	NC
Lung	23	33.2	69	44--104	15	21.0	71	40--118	8	12.3	65	28--129
Pancreas	10	4.8	210 *	101--386	5	2.4	205	66--480	5	2.3	215	69--501
Stomach	2	4.8	NC	NC	1	3.1	NC	NC	1	1.7	NC	NC
Hodgkins	1	1.9	NC	NC	1	1.0	NC	NC	0	0.9	NC	NC
NHL	8	7.6	106	46--209	6	4.1	147	54--319	2	3.5	NC	NC
Leukemia	6	4.2	142	52--309	2	2.5	NC	NC	4	1.7	NC	NC

Notes:
Expected number of cases presented are rounded to the nearest tenth. SIRs are calculated based on the exact number of expected cases.
SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance (P<.05)

Table 2B

Cancer Incidence in Census Tract 3821, Natick, MA 1982-1986 and 1987-1992

1982-1986

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	1	4.4	NC	NC	1	3.3	NC	NC	0	1.1	NC	NC
Brain	1	1.4	NC	NC	1	0.8	NC	NC	0	0.6	NC	NC
Breast	20	15.3	131	80--202	1	0.1	NC	NC	19	15.2	125	75--196
Kidney	2	2.0	NC	NC	0	1.2	NC	NC	2	0.7	NC	NC
Liver	0	0.4	NC	NC	0	0.3	NC	NC	0	0.1	NC	NC
Lung	8	14.7	55	24--108	5	9.7	52	17--121	3	5.0	NC	NC
Pancreas	8	2.2	361 *	155--710	4	1.1	NC	NC	4	1.1	NC	NC
Stomach	1	2.3	NC	NC	0	1.5	NC	NC	1	0.8	NC	NC
Hodgkins	0	0.9	NC	NC	0	0.5	NC	NC	0	0.4	NC	NC
NHL	2	3.1	NC	NC	1	1.6	NC	NC	1	1.4	NC	NC
Leukemia	2	2.0	NC	NC	2	1.1	NC	NC	0	0.8	NC	NC

1987-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	5	5.3	94	30--219	3	4.0	NC	NC	2	1.3	NC	NC
Brain	0	2.0	NC	NC	0	1.1	NC	NC	0	0.9	NC	NC
Breast	23	22.0	103	65--155	0	0.1	NC	NC	23	22.0	104	66--156
Kidney	4	3.3	NC	NC	1	2.1	NC	NC	3	1.2	NC	NC
Liver	0	0.6	NC	NC	0	0.5	NC	NC	0	0.2	NC	NC
Lung	15	18.6	81	45--133	10	11.3	88	42--163	5	7.3	69	22--161
Pancreas	2	2.5	NC	NC	1	1.3	NC	NC	1	1.2	NC	NC
Stomach	1	2.4	NC	NC	1	1.6	NC	NC	0	0.9	NC	NC
Hodgkins	1	1.0	NC	NC	1	0.6	NC	NC	0	0.5	NC	NC
NHL	6	4.5	134	49--292	5	2.4	206	66--480	1	2.0	NC	NC
Leukemia	4	2.3	NC	NC	0	1.4	NC	NC	4	0.9	NC	NC

Notes:
Expected number of cases presented are rounded to the nearest tenth. SIRs are calculated based on the exact number of expected cases.
SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance ($P<.05$)

Table 3A

Cancer Incidence in Census Tract 3822, Natick, MA 1982-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	13	9.6	135	72--231	8	7.0	113	49--222	5	2.5	196	63--456
Brain	3	3.5	NC	NC	3	1.9	NC	NC	0	1.6	NC	NC
Breast	35	38.7	91	63--126	0	0.2	NC	NC	35	38.4	91	63--127
Kidney	6	5.2	116	42--253	4	3.2	NC	NC	2	2.0	NC	NC
Liver	0	1.1	NC	NC	0	0.8	NC	NC	0	0.3	NC	NC
Lung	41	32.4	127	91--172	23	20.1	115	73--172	18	12.3	146	87--231
Pancreas	6	4.8	126	46--274	5	2.4	212	68--495	1	2.4	NC	NC
Stomach	3	4.8	NC	NC	1	3.0	NC	NC	2	1.8	NC	NC
Hodgkins	1	2.1	NC	NC	1	1.1	NC	NC	0	1.0	NC	NC
NHL	7	7.7	91	36--187	1	4.1	NC	NC	6	3.6	165	60--360
Leukemia	4	4.3	NC	NC	2	2.5	NC	NC	2	1.9	NC	NC

Notes:
Expected number of cases presented are rounded to the nearest tenth. SIRs are calculated based on the exact number of expected cases.
SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance (P<.05)

Table 3B

Cancer Incidence in Census Tract 3822, Natick, MA 1982-1986 and 1987-1992

1982-1986

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	8	4.4	183	79--361	5	3.2	156	50--364	3	1.2	NC	NC
Brain	2	1.4	NC	NC	2	0.8	NC	NC	0	0.7	NC	NC
Breast	17	15.7	108	63--173	0	0.1	NC	NC	17	15.6	109	63--174
Kidney	3	1.9	NC	NC	3	1.2	NC	NC	0	0.8	NC	NC
Liver	0	0.4	NC	NC	0	0.3	NC	NC	0	0.1	NC	NC
Lung	18	14.2	126	75--200	11	9.2	119	59--213	7	5.0	140	56--288
Pancreas	3	2.2	NC	NC	3	1.1	NC	NC	0	1.1	NC	NC
Stomach	2	2.3	NC	NC	0	1.5	NC	NC	2	0.9	NC	NC
Hodgkins	0	1.0	NC	NC	0	0.5	NC	NC	0	0.4	NC	NC
NHL	4	3.1	NC	NC	1	1.6	NC	NC	3	1.5	NC	NC
Leukemia	2	2.0	NC	NC	1	1.1	NC	NC	1	0.9	NC	NC

1987-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	5	5.3	95	31--222	3	3.9	NC	NC	2	1.4	NC	NC
Brain	1	2.1	NC	NC	1	1.1	NC	NC	0	0.9	NC	NC
Breast	18	22.9	79	47--124	0	0.1	NC	NC	18	22.7	79	47--125
Kidney	3	3.2	NC	NC	1	2.0	NC	NC	2	1.2	NC	NC
Liver	0	0.6	NC	NC	0	0.4	NC	NC	0	0.2	NC	NC
Lung	23	18.1	127	81--191	12	10.8	111	57--194	11	7.3	151	75--271
Pancreas	3	2.5	NC	NC	2	1.3	NC	NC	1	1.3	NC	NC
Stomach	1	2.5	NC	NC	1	1.5	NC	NC	0	0.9	NC	NC
Hodgkins	1	1.2	NC	NC	1	0.6	NC	NC	0	0.6	NC	NC
NHL	3	4.6	NC	NC	0	2.4	NC	NC	3	2.1	NC	NC
Leukemia	2	2.3	NC	NC	1	1.3	NC	NC	1	1.0	NC	NC

Notes:
Expected number of cases presented are rounded to the nearest tenth. SIRs are calculated based on the exact number of expected cases.
SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance ($P < .05$)

Table 4A

Cancer Incidence in Census Tract 3823, Natick, MA 1982-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	16	10.0	159	91--259	13	7.2	181	96--310	3	2.9	NC	NC
Brain	4	3.4	NC	NC	1	1.9	NC	NC	3	1.6	NC	NC
Breast	43	38.9	110	80--149	0	0.2	NC	NC	43	38.7	111	80--149
Kidney	2	5.2	NC	NC	1	3.1	NC	NC	1	2.0	NC	NC
Liver	1	1.1	NC	NC	1	0.7	NC	NC	0	0.3	NC	NC
Lung	29	32.1	90	61--130	13	19.9	66	35--112	16	12.2	131	75--212
Pancreas	10	5.0	198	95--365	6	2.3	256	93--556	4	2.7	NC	NC
Stomach	5	5.2	97	31--226	4	3.0	NC	NC	1	2.1	NC	NC
Hodgkins	1	2.1	NC	NC	1	1.1	NC	NC	0	1.0	NC	NC
NHL	5	7.9	63	20--148	3	4.0	NC	NC	2	3.9	NC	NC
Leukemia	6	4.5	134	49--292	0	2.5	NC	NC	6	2.0	302 *	110--657

Notes:
Expected number of cases presented are rounded to the nearest tenth. SIRs are calculated based on the exact number of expected cases.
SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance (P<.05)

Table 4B

Cancer Incidence in Census Tract 3823, Natick, MA 1982-1986 and 1987-1992

1982-1986

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	4	4.6	NC	NC	4	3.2	NC	NC	0	1.3	NC	NC
Brain	1	1.4	NC	NC	1	0.8	NC	NC	0	0.6	NC	NC
Breast	21	16.0	132	81--201	0	0.1	NC	NC	21	15.9	132	82--202
Kidney	0	1.9	NC	NC	0	1.2	NC	NC	0	0.8	NC	NC
Liver	0	0.4	NC	NC	0	0.3	NC	NC	0	0.1	NC	NC
Lung	14	14.1	99	54--167	8	9.1	88	38--173	6	5.0	121	44--263
Pancreas	5	2.4	211	68--493	3	1.1	NC	NC	2	1.3	NC	NC
Stomach	2	2.5	NC	NC	2	1.5	NC	NC	0	1.0	NC	NC
Hodgkins	0	0.9	NC	NC	0	0.5	NC	NC	0	0.4	NC	NC
NHL	4	3.2	NC	NC	2	1.6	NC	NC	2	1.6	NC	NC
Leukemia	5	2.1	241	78--562	0	1.1	NC	NC	5	0.9	530 *	171--1237

1987-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	12	5.5	220 *	114--384	9	3.9	230 *	105--437	3	1.5	NC	NC
Brain	3	2.0	NC	NC	0	1.1	NC	NC	3	0.9	NC	NC
Breast	22	22.9	96	60--145	0	0.1	NC	NC	22	22.7	97	61--146
Kidney	2	3.2	NC	NC	1	2.0	NC	NC	1	1.3	NC	NC
Liver	1	0.6	NC	NC	1	0.4	NC	NC	0	0.2	NC	NC
Lung	15	17.9	84	47--138	5	10.7	47	15--109	10	7.3	138	66--253
Pancreas	5	2.7	187	60--437	3	1.3	NC	NC	2	1.4	NC	NC
Stomach	3	2.6	NC	NC	2	1.6	NC	NC	1	1.1	NC	NC
Hodgkins	1	1.1	NC	NC	1	0.6	NC	NC	0	0.5	NC	NC
NHL	1	4.7	NC	NC	1	2.4	NC	NC	0	2.3	NC	NC
Leukemia	1	2.4	NC	NC	0	1.3	NC	NC	1	1.0	NC	NC

Notes:
Expected number of cases presented are rounded to the nearest tenth. SIRs are calculated based on the exact number of expected cases.
SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance ($P<.05$)

Table 5A

Cancer Incidence in Census Tract 3824, Natick, MA 1982-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	11	10.0	110	55--196	7	6.9	101	41--209	4	3.1	NC	NC
Brain	5	3.2	157	51--366	4	1.6	NC	NC	1	1.5	NC	NC
Breast	41	39.7	103	74--140	0	0.2	NC	NC	41	39.5	104	74--141
Kidney	4	5.1	NC	NC	3	2.9	NC	NC	1	2.2	NC	NC
Liver	2	1.0	NC	NC	1	0.7	NC	NC	1	0.3	NC	NC
Lung	31	31.7	98	66--139	15	18.8	80	45--132	16	13.0	123	70--200
Pancreas	6	5.2	115	42--249	2	2.2	NC	NC	4	3.0	NC	NC
Stomach	4	5.3	NC	NC	1	2.9	NC	NC	3	2.4	NC	NC
Hodgkins	3	1.8	NC	NC	2	0.9	NC	NC	1	0.8	NC	NC
NHL	12	7.8	154	79--268	6	3.7	163	59--354	6	4.1	146	53--317
Leukemia	2	4.3	NC	NC	0	2.3	NC	NC	2	2.1	NC	NC

Notes:
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SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance ($P<.05$)

Table 5B

Cancer Incidence in Census Tract 3824, Natick, MA 1982-1986 and 1987-1992

1982-1986

Cancer Type	Total				Male				Female			
	Obs		SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	2	4.6	NC	NC	0	3.1	NC	NC	2	1.4	NC	NC
Brain	3	1.3	NC	NC	2	0.7	NC	NC	1	0.6	NC	NC
Breast	11	16.3	68	34--121	0	0.1	NC	NC	11	16.2	68	34--121
Kidney	2	1.9	NC	NC	2	1.1	NC	NC	0	0.8	NC	NC
Liver	1	0.4	NC	NC	0	0.3	NC	NC	1	0.2	NC	NC
Lung	14	13.8	101	55--170	6	8.6	70	25--151	8	5.2	153	66--302
Pancreas	1	2.5	NC	NC	0	1.0	NC	NC	1	1.4	NC	NC
Stomach	4	2.6	NC	NC	1	1.4	NC	NC	3	1.2	NC	NC
Hodgkins	2	0.8	NC	NC	1	0.4	NC	NC	1	0.4	NC	NC
NHL	5	3.2	158	51--369	2	1.5	NC	NC	3	1.7	NC	NC
Leukemia	1	2.0	NC	NC	0	1.0	NC	NC	1	1.0	NC	NC

1987-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	9	5.5	165	75--313	7	3.8	186	74--383	2	1.7	NC	NC
Brain	2	1.9	NC	NC	2	1.0	NC	NC	0	0.9	NC	NC
Breast	30	23.4	128	87--183	0	0.1	NC	NC	30	23.2	129	87--184
Kidney	2	3.1	NC	NC	1	1.8	NC	NC	1	1.3	NC	NC
Liver	1	0.6	NC	NC	1	0.4	NC	NC	0	0.2	NC	NC
Lung	17	17.8	95	55--153	9	10.1	89	40--169	8	7.7	103	45--204
Pancreas	5	2.8	180	58--421	2	1.2	NC	NC	3	1.6	NC	NC
Stomach	0	2.7	NC	NC	0	1.5	NC	NC	0	1.2	NC	NC
Hodgkins	1	1.0	NC	NC	1	0.5	NC	NC	0	0.5	NC	NC
NHL	7	4.6	152	61--312	4	2.2	NC	NC	3	2.4	NC	NC
Leukemia	1	2.3	NC	NC	0	1.2	NC	NC	1	1.1	NC	NC

Notes:
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SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
Obs = Observed number of cases Exp = Expected number of cases SIR = Standardized Incidence Ratio NC = Not Calculated
NHL = non-Hodgkin's Lymphoma Lung = Lung and Bronchus 95% CI = 95% Confidence Interval * Indicates statistical significance ($P < .05$)

Table 6A

Cancer Incidence in Census Tract 3825, Natick, MA 1982-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	12	9.5	127	65--221	10	6.9	145	69--267	2	2.6	NC	NC
Brain	3	3.0	NC	NC	1	1.6	NC	NC	2	1.3	NC	NC
Breast	35	34.5	102	71--141	0	0.2	NC	NC	35	34.2	102	71--142
Kidney	3	4.7	NC	NC	2	2.9	NC	NC	1	1.8	NC	NC
Liver	1	1.0	NC	NC	0	0.7	NC	NC	1	0.3	NC	NC
Lung	20	29.7	67	41--104	13	18.6	70	37--119	7	11.1	63	25--131
Pancreas	5	4.7	106	34--249	3	2.2	NC	NC	2	2.5	NC	NC
Stomach	7	4.8	145	58--298	2	2.9	NC	NC	5	1.9	259	83--604
Hodgkins	2	1.7	NC	NC	2	0.9	NC	NC	0	0.8	NC	NC
NHL	5	7.2	70	22--163	4	3.7	NC	NC	1	3.5	NC	NC
Leukemia	3	4.0	NC	NC	2	2.1	NC	NC	1	1.8	NC	NC

Notes:
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SIRs and 95% Confidence Interval are not calculated when fewer than 5 cases are observed.
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Table 6B

Cancer Incidence in Census Tract 3825, Natick, MA 1982-1986 and 1987-1992

1982-1986

Cancer	Total				Male				Female			
Type	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	4	4.3	NC	NC	2	3.1	NC	NC	2	1.2	NC	NC
Brain	2	1.2	NC	NC	1	0.7	NC	NC	1	0.5	NC	NC
Breast	15	14.1	106	59--175	0	0.1	NC	NC	15	14.0	107	60--176
Kidney	0	1.8	NC	NC	0	1.1	NC	NC	0	0.7	NC	NC
Liver	0	0.4	NC	NC	0	0.3	NC	NC	0	0.1	NC	NC
Lung	8	13.0	61	26--121	4	8.6	NC	NC	4	4.5	NC	NC
Pancreas	3	2.2	NC	NC	1	1.0	NC	NC	2	1.2	NC	NC
Stomach	3	2.4	NC	NC	1	1.4	NC	NC	2	1.0	NC	NC
Hodgkins	1	0.8	NC	NC	1	0.4	NC	NC	0	0.4	NC	NC
NHL	1	2.9	NC	NC	1	1.5	NC	NC	0	1.4	NC	NC
Leukemia	1	1.9	NC	NC	1	1.0	NC	NC	0	0.8	NC	NC

1987-1992

Cancer	Total				Male				Female			
Type	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	8	5.2	155	67--306	8	3.8	213	92--420	0	1.4	NC	NC
Brain	1	1.8	NC	NC	0	0.9	NC	NC	1	0.8	NC	NC
Breast	20	20.3	98	60--152	0	0.1	NC	NC	20	20.2	99	61--153
Kidney	3	2.9	NC	NC	2	1.8	NC	NC	1	1.3	NC	NC
Liver	1	0.6	NC	NC	0	0.4	NC	NC	1	0.2	NC	NC
Lung	12	16.6	72	37--126	9	10.0	90	41--170	3	6.6	NC	NC
Pancreas	2	2.5	NC	NC	2	1.2	NC	NC	0	1.3	NC	NC
Stomach	4	2.5	NC	NC	1	1.5	NC	NC	3	1.0	NC	NC
Hodgkins	1	0.9	NC	NC	1	0.5	NC	NC	0	0.4	NC	NC
NHL	4	4.2	NC	NC	3	2.2	NC	NC	1	2.0	NC	NC
Leukemia	2	2.1	NC	NC	1	1.2	NC	NC	1	0.9	NC	NC

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Table 7A

Cancer Incidence in Census Tract 3826, Natick, MA 1982-1992

Cancer	Total				Male				Female			
Type	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	10	12.8	78	37--143	6	9.2	65	24--142	4	3.6	NC	NC
Brain	7	4.7	149	60--307	3	2.5	NC	NC	4	2.2	NC	NC
Breast	61	52.0	117	90--151	0	0.3	NC	NC	61	51.7	118	89--149
Kidney	13	6.7	193 *	103--331	8	4.1	197	85--388	5	2.7	188	61--439
Liver	1	1.4	NC	NC	0	1.0	NC	NC	1	0.4	NC	NC
Lung	46	41.4	111	81--148	28	25.5	110	73--159	18	15.9	113	67--179
Pancreas	4	6.4	NC	NC	1	3.0	NC	NC	3	3.4	NC	NC
Stomach	4	6.6	NC	NC	1	3.9	NC	NC	3	2.7	NC	NC
Hodgkins	5	3.2	156	50--365	3	1.7	NC	NC	2	1.5	NC	NC
NHL	12	10.5	114	59--199	3	5.4	NC	NC	9	5.1	177	81--336
Leukemia	4	5.8	NC	NC	2	3.2	NC	NC	2	2.6	NC	NC

Notes:
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Table 7B

Cancer Incidence in Census Tract 3826, Natick, MA 1982-1986 and 1987-1992

1982-1986

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	5	5.8	86	28--200	4	4.2	NC	NC	1	1.7	NC	NC
Brain	3	1.9	NC	NC	2	1.1	NC	NC	1	0.9	NC	NC
Breast	20	21.2	94	57--145	0	0.1	NC	NC	20	21.1	95	58--146
Kidney	5	2.5	199	64--463	4	1.5	NC	NC	1	1.0	NC	NC
Liver	0	0.6	NC	NC	0	0.4	NC	NC	0	0.2	NC	NC
Lung	17	18.2	94	54--150	9	11.7	77	35--146	8	6.5	124	53--244
Pancreas	0	3.0	NC	NC	0	1.4	NC	NC	0	1.6	NC	NC
Stomach	1	3.2	NC	NC	0	1.9	NC	NC	1	1.3	NC	NC
Hodgkins	3	1.4	NC	NC	2	0.8	NC	NC	1	0.7	NC	NC
NHL	2	4.2	NC	NC	1	2.1	NC	NC	1	2.1	NC	81--336
Leukemia	3	2.7	NC	NC	2	1.5	NC	NC	1	1.2	NC	NC

1987-1992

Cancer Type	Total				Male				Female			
	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI	Obs	Exp	SIR	95% CI
Bladder	5	7.0	72	23--167	2	5.0	NC	NC	3	2.0	NC	NC
Brain	4	2.7	NC	NC	1	1.5	NC	NC	3	1.3	NC	NC
Breast	41	31.0	134	96--182	0	0.2	NC	NC	41	30.4	135	97--183
Kidney	8	4.2	192	82--377	4	2.5	NC	NC	4	1.6	NC	NC
Liver	1	0.8	NC	NC	0	0.6	NC	NC	1	0.2	NC	NC
Lung	29	23.2	125	84--180	19	13.7	138	83--216	10	9.4	106	51--195
Pancreas	4	3.4	NC	NC	1	1.6	NC	NC	3	1.8	NC	NC
Stomach	3	3.4	NC	NC	1	2.0	NC	NC	2	1.4	NC	NC
Hodgkins	2	1.7	NC	NC	1	0.9	NC	NC	1	0.8	NC	NC
NHL	10	6.3	160	76--294	2	3.3	NC	NC	8	3.0	267 *	115--527
Leukemia	1	3.1	NC	NC	0	1.8	NC	NC	1	1.4	NC	NC

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CERTIFICATION

The Assessment of Cancer Incidence in Natick, Massachusetts for 1982-1992 Health Consultation was prepared by the Massachusetts Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Health Consultation was initiated.

Technical Project Officer, SPS, SSAB, DHAC

The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with its findings.

Chief, SPS, SSAB, DHAC, ATSDR